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Combustion Air Supply Codes in Housing

A RESEARCH REPORT

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Combustion Air Supply Codes in Housing

A RESEARCH REPORT

A Review of Current Codes and Standards

Sponsored by the
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ABSTRACT

This report reviews the various codes and standards that deal with supplying combustion air to fuel-fired appliances in houses and mobile homes. The technical basis for the specific requirements is examined and the degree of compliance is indicated.

The work was conducted by reviewing the National Building Code and the specific standards that apply to the installation of gas-fired, oil-fired, and solid fuel-fired equipment. Information was also gathered on expected changes to the codes and standards. Interviews were conducted with national and provincial building code officials as well as with combustion engineers and industry representatives.

Codes and standards are written by committees and the requirements are determined by consensus. The requirements for combustion air supply are based on traditional rules of thumb, which err on the side of safety, and experts regard the specified opening sizes as being too large. The study was not able to find any hard technical basis for any of the requirements.

Outside air supply is currently only required in mobile homes and in "tight" houses -- those without sufficient infiltration to supply air for combustion. No tests are required to determine how tight the houses actually are or even how much air is needed.

Most new construction in urban Canada is covered by locally enforced building codes but enforcement for retrofit installations varies and in much of rural Canada there are no requirements or inspections of any kind. For mobile homes, the requirements are enforced at the factory.

Combustion air supply in the new generation of tighter houses is rapidly becoming a complex issue and there are no simple solutions although most people in the industry seem to be aware of the problem. Fortunately, codes and standards can be continually modified and refined to reflect current technology.

RÉSUMÉ

Le présent rapport porte sur les divers codes et normes qui régissent l'alimentation en air comburant des appareils à combustible dans les maisons et dans les habitations mobiles. On y examine les fondements techniques des exigences spécifiques, et on indique dans quelle mesure les codes et les normes sont respectés.

On a passé en revue le Code national du Bâtiment et les normes concernant spécifiquement l'installation des appareils au gaz, au mazout et à combustible solide, en tenant compte des modifications susceptibles d'y être apportées. On a également interviewé les responsables des codes du bâtiment à l'échelle nationale et provinciale, des spécialistes de la combustion et des représentants de l'industrie.

Les codes et les normes sont élaborés par des comités qui prennent leurs décisions par voie de consensus. Pour ce qui est de l'alimentation en air comburant, les exigences retenues reposent sur des observations empiriques qui sont relativement contestables sur le plan de la sécurité, puisque les experts considèrent que les dimensions des prises d'air fixées par les normes sont trop grandes. En outre, aucune des normes n'a pu être justifiée par des fondements techniques solides.

Les normes actuelles n'exigent une alimentation en air frais que dans les habitations mobiles et dans les maisons étanches, qui n'admettent pas suffisamment d'air comburant. Toutefois, aucun essai n'est imposé pour déterminer le niveau d'étanchéité réel des maisons ni même la quantité d'air nécessaire.

La plupart des nouvelles maisons en zone urbaine sont régies par le code du bâtiment local mais l'application des normes d'amélioration thermique est variable. Il n'existe, par ailleurs, aucune norme ou inspection dans de nombreuses régions rurales. En ce qui concerne les habitations mobiles, le respect des normes incombe au fabricant.

L'alimentation en air comburant de la nouvelle génération de maisons étanches pose un problème de plus en plus complexe auquel il n'existe à ce jour aucune solution simple, même si l'industrie semble en général consciente de la situation. Heureusement, les codes et les normes ne sont pas figés et peuvent être modifiés et perfectionnés en fonction du progrès technologique.

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This report examines the various codes and standards dealing with the supply of combustion air to fuel-fired heating equipment in Canadian houses and mobile homes. It explains the general technical basis for the requirements and it discusses how they are being enforced across the country.

Actual quotations taken from the codes are highlighted in boldface type to set them apart from the rest of the report.

During the data gathering, contact was made with a variety of officials, building inspectors, and representatives of the residential heating industry. These people freely discussed their interpretation of the codes and often supplied personal, unofficial opinions to help clarify the situation. A draft copy of the report was circulated to 37 of the interviewed sources and their comments and corrections have been incorporated. Readers are cautioned not to take any specific comments based on these interviews out of context.

Two significant events have taken place since the study was completed in the spring of 1985.

First, the 1985 edition of the National Building Code has been released and is in the process of being adopted by jurisdictions across the country. References to the 1985 NBC have been changed in the text from the future tense to the present. Second, the gas installation code, B149, has been revised and is expected to be released in early 1986. A new subsection has been added to Chapter 4 to explain the new requirements.

With the possible exception of the R2000 program, no other changes to combustion air supply requirements are on the horizon.

Le présent rapport passe en revue les exigences les plus récentes énoncées dans les codes et normes canadiens relativement à l'alimentation en air comburant des maisons et des habitations mobiles. On y examine les fondements techniques de ces exigences et leur application au Canada à partir d'entretiens avec les responsables des codes du bâtiment et des représentants de l'industrie. Le rapport porte également sur les exigences plus spécifiques des programmes de construction de maisons à faible consommation d'énergie.

Code national du Bâtiment

Les normes qui régissent l'alimentation en air comburant des maisons sont énoncées dans le Code national du Bâtiment, qui se limite à deux exigences générales destinées aux constructeurs, à savoir : utiliser des techniques de génie civil efficaces et trouver le moyen d'alimenter la maison en air comburant. Dans sa version de 1980 et de 1985, le CNB stipule que le constructeur doit se conformer aux normes d'installation appropriées, qui comportent elles-mêmes certaines exigences en matière d'air comburant. Le CNB prend pour acquis que, sauf celles qui sont dites "étanches", la plupart des maisons admettent suffisamment d'air comburant. Cependant, on ne trouve dans le Code aucun essai d'étanchéité et il semble bien qu'il n'y ait aucun moyen de déterminer si les constructeurs répondent à cette exigence.

Codes d'installation

Les codes d'installation sont élaborés par l'Association canadienne de normalisation pour les appareils au mazout et les appareils à combustible solide, et par l'Association canadienne du gaz pour les appareils fonctionnant au gaz et au propane.

Mazout et gaz

Il n'y a que dans les maisons étanches que l'installation d'appareils au mazout et au gaz doit respecter des dimensions prescrites pour les conduits et les prises d'air extérieur. Les dimensions et la configuration des appareils de chauffage varient en outre selon l'emplacement et la capacité de l'appareil. On envisage toutefois de publier certaines modifications des codes d'installation des appareils au gaz au début de 1986. Enfin, aucun des responsables interrogés ne pouvait citer de recherche sérieuse sur les dimensions des prises d'air mais tous s'entendaient pour dire qu'elles étaient raisonnables quoique peut-être un peu grandes.

Combustible solide

Le CNB de 1985 exige que tous les foyers et chaufferettes à combustible solide soient installés de manière à permettre l'évacuation complète des produits de combustion, et dotés d'un système qui compense le volume d'air évacué par d'autres appareils de la maison. Toutefois, le code ne précise par les modalités d'application de cette norme et ne fournit aucun essai de conformité.

Le code d'installation des appareils à combustible solide s'applique aux systèmes de chauffage central. Il exige un système d'alimentation en air extérieur si l'infiltration naturelle est insuffisante. Pour déterminer les dimensions appropriées, le code recommande une méthode empirique selon laquelle la surface de la prise d'air doit être égale à la moitié de celle de la buse, et doit respecter en plus un rapport de 3,3 mm2 par watt de puissance de chauffage. Le code précise également la longueur et le diamètre minimums des conduits mais, là encore, c'est en fonction d'observations empiriques généralement admises et considérées comme raisonnables, qui n'ont aucun fondement technique solide.

Habitations mobiles

Les habitations mobiles sont inspectées en usine et homologuées par l'Association canadienne de normalisation en fonction d'une série de normes qui exigent que les appareils à combustion soient dotés d'un système d'alimentation en air comburant distinct. Les conduits d'air comburant des appareils à chambre de combustion étanche et à échappement direct sont calibrés et fournis par le fabricant. Pour les appareils à chambre de combustion non étanche, l'ACNOR précise les dimensions des ouvertures.

C'est le code d'installation des appareils au gaz dans les habitations mobiles qui fournit la seule norme spécifique de renouvellement de l'air dont le présent rapport puisse faire état. La norme ACNOR Z240.4.1-M1983 exige en effet dans les habitations mobiles la présence d'un conduit d'air extérieur à proximité d'une sécheuse de linge au gaz. La surface de l'ouverture du conduit doit être au moins deux fois supérieure à celle de l'évent de la sécheuse.

Fondements techniques

Les codes et les normes sont élaborés par voie de consensus au sein de comités composés de scientifiques et de représentants de l'industrie et d'autres groupes d'intérêts. Pour fixer les exigences en matière d'air comburant, ces comités ont dû s'en remettre à des lignes directrices établies à partir d'une longue expérience sur le terrain. Les spécialistes de la combustion, quant à eux, considèrent que les dimensions des conduits et des prises d'air sont techniquement fiables mais trop grandes pour garantir une parfaite sécurité.

Il se peut que les spécifications énoncées dans les codes s'appuient à l'origine sur des hypothèses théoriques applicables au taux d'échange d'air dans des constructions plus anciennes, mais il a été impossible, au cours de la présente étude, de retracer des essais spécifiques ou d'autres recherches à l'appui des exigences énoncées dans les codes en matière d'air comburant.

Les spécialistes font remarquer que même les conduits dirigés vers l'extérieur sont parfois insuffisants si l'évent crée temporairement une zone de pression négative autour de la prise d'air ou si d'autres appareils ménagers, comme les ventilateurs aspirants ou les systèmes d'aspirateur central, viennent court-circuiter l'entrée d'air extérieur.

Conformité

Dans les provinces et les territoires, les autorités ont soit décidé d'adopter elles-mêmes le CNB, soit exigé des municipalités qu'elles le fassent. Ainsi, la plupart des provinces sont censées exiger la conformité au CNB de 1985 d'ici le début de 1986. Le CNB était du reste déjà en vigueur dans plusieurs régions à la fin de 1985. L'application du Code du bâtiment incombe toujours aux autorités locales.

Les installations d'appareils au gaz font habituellement l'objet d'une inspection de la part de la province ou des services publics et semblent respecter les exigences du code d'installation. En Alberta, tous les appareils au gaz doivent être alimentés en air frais tandis que dans les Territoires du Nord-Ouest, tout équipement à combustion dans les nouvelles maisons doit être muni d'un conduit d'air frais dont l'orifice doit avoir un diamètre équivalant au moins à la moitié de celui de la cheminée.

Pour ce qui est des nouvelles constructions, les systèmes au mazout ou à combustible solide sont habituellement inspectés par les autorités locales mais il semble que les travaux d'amélioration thermique des équipements ne soient pas toujours régis par le code du bâtiment. En fait, bon nombre de régions agricoles du Canada y échappent complètement.

L'installation de la plupart des poêles à bois dans les maisons existantes se fait sans permis ni inspection, soit parce que le propriétaire contourne la loi, soit parce que les autorités locales n'exigent pas de permis pour ce type d'installation. Or, les compagnies d'assurance exigent en général une approbation officielle pour toutes les installations de poêle à bois avant d'assurer un propriétaire.

Solutions

Si on est unanime à reconnaître la complexité du problème que pose l'alimentation en air comburant et le renouvellement de l'air, particulièrement dans les maisons étanches, on n'a encore proposé à ce jour aucune solution simple qui puisse être intégrée à un code, utilisée par des installateurs de divers niveaux de compétence technique, ou offrir des garanties d'efficacité à long terme si les propriétaires effectuent des travaux de rénovation.

Les comités d'élaboration des codes se contentent de signaler les aspects qui font problème en utilisant des phrases types comme "il faut assurer une alimentation suffisante en air comburant" ou "il faut compenser" mais ne proposent aucune solution et n'exigent aucun essai de conformité. On semble s'entendre pour dire que le problème affecte en général les maisons étanches équipées de foyers, particulièrement celles où fonctionnent en plus des appareils ménagers au gaz qui aspirent de l'air.

Programme R2000

Les exigences les plus précises sont énoncées dans le Programme R2000 de EMR, qui proscrit l'utilisation d'équipement naturellement aspirant, ne permet que les systèmes de chauffage à chambre de combustion étanche ou à air pulsé, et stipule que les appareils à combustible solide, y compris les foyers, doivent être munis d'un système distinct d'alimentation en air comburant. Dans le cadre de ce programme, des règlements plus sévères sont entrés en vigueur en avril 1985.

Constructeur de maisons à faible consommation d'énergie

Plusieurs constructeurs de maisons à faible consommation d'énergie interviewés au cours de l'étude ont expliqué qu'ils contournaient le problème en n'utilisant aucun équipement à combustion (sauf des poêles à bois expulsant leurs produits de combustion vers l'extérieur). Ils préfèrent en effet installer dans les maisons étanches des systèmes de chauffage électriques à air pulsé.

Autre solution possible

Pour résoudre le problème du calibrage des prises d'air comburant, plusieurs personnes interviewées ont recommandé d'indiquer les exigences en air comburant sur le certificat d'homologation de chaque appareil. Rien n'indique toutefois que les comités d'élaboration des normes envisagent de mettre cette suggestion en pratique.

1.0 INTRODUCTION

The supply of combustion air for residential heating appliances has rapidly become one of the major issues facing the Canadian housing industry.

How much combustion air to supply, how to supply it, and how to compensate for air exhausted by other household appliances are questions that Canadian building-code-writing authorities have been addressing. The basic problem is outlined in the 1985 edition of the National Building Code:

> **The operation of an air exhaust system or of a fuel-burning appliance removes the air from a house, creating a slight negative pressure inside. In certain cases, the natural flow of air up a chimney can be reversed, leading to a possible danger of carbon monoxide poisoning for the inhabitants.**
>
> **Newer houses are generally more tightly constructed than older ones because of improved construction practices, including tighter windows, weather stripping and caulking. This fact increases the probability that infiltration may not be able to supply enough air to compensate for simultaneous operation of exhaust fans, fireplaces, clothes dryers, furnaces and space heaters.**

1.1 Codes and Standards

The difference between codes and standards is not clear. Very loosely defined, codes are requirements that are enacted in legislation to cover construction, operation and installations, with health and safety usually being the overriding rationale. Standards are written by accredited standards writing organizations, such as the Canadian Standards Association, and usually apply to products where they are used for approval or certification.

In this case, the National Building Code requires compliance with specified equipment installation codes. The installation codes, in turn, contain requirements for combustion air supply and for the equipment itself to meet certain product standards.

1.2 The National Building Code

Published by the National Research Council, the National Building Code is a model set of technical requirements for ensuring public safety in buildings. The Code is written in a form suitable for adoption by legislative authorities and has received wide use in Canada, either as municipal bylaws or as a provincial building code.

The National Building Code (NBC) is developed with the voluntary assistance of building experts on the Associate Committee on the National Building Code (ACNBC) and on its Standing Committees to ensure that the document keeps pace with advances in building technology.

NRC's Division of Building Research provides technical and secretarial support, at the direction of the ACNBC, to make available the most up-to-date information on building technology. The Associate Committee is assisted by a number of Standing Committees covering such areas as structural design, plumbing and housing. The Standing Committee on Heating, Ventilating and Air Conditioning has the responsibility for determining how to supply combustion air. The jurisdiction to provide detailed requirements, however, lies with the standards writing agencies.

1.3 Standards for Combustion Appliances

House Requirements

Residential gas and oil installations are required by the National Building Code to conform to standards developed by the Canadian Gas Association (CGA) and the Canadian Standards Association (CSA). These "consensus" standards are developed by committees representing industry, regulatory agencies, and special interest groups.

Solid-fuel appliance installations are covered by various requirements in the 1980 NBC, but the 1985 edition specifies new CSA standards written after the 1980 Code was released.

Mobile Home Requirements

According to NRC officials, the NBC is intended to apply to mobile homes. Subsection 2.1.4 of both the 1980 and 1985 editions states:

This Code applies to both site assembled and factory made buildings.

The Ontario Building Code, however, distinguishes between manufactured buildings and mobile homes. Factory-prefabricated modular houses are installed on foundations and are required to meet Building Code requirements whereas mobile homes must conform to a special series of CSA standards. CSA standard A277, "Procedure for Certification of Factory-Built Houses" also specifies that manufactured homes must conform to the National Building Code while mobile homes must conform to the CSA Z240 series.

Mobile homes are structurally complete and equipped with plumbing, electrical and heating systems when they leave the factory. Mobile home manufacturers voluntarily have their units certified at the factory by the Canadian Standards Association to the CSA Z-240 standards with fuel-specific requirements. Virtually all jurisdictions which allow mobile homes require CSA certification.

The problems associated with combustion air supply are avoided in mobile homes as combustion systems are required by the various Z-240 standards to draw their combustion air from outside.

Standard Writing Bodies

Both CGA and CSA are independent, autonomous organizations that have developed standards which reflect a reasonable agreement among the views of representatives of government, industry, and special interest groups. These standards are developed on the consensus principle, and represent the cumulative common sense, experience, and technical expertise of the committee members who draft them.

1.4 Code Adoption and Jurisdictions

Although the National Building Code is generated at the national level, it must be adopted at either the provincial or municipal level and then enforced locally. Once the NBC has been adopted by the appropriate jurisdiction, permits are normally required before combustion appliances can be installed and usually a final inspection or test takes place when the work has been completed. Some provinces mandate oil and gas installations with separate legislation.

Mobile homes are certified by CSA at the factory and therefore have met all their standards requirements before delivery to the market.

Code Adoption

Most provinces and the territories have adopted the National Building Code; the other provinces require the municipalities to adopt their own building code but accept only the NBC. Occasionally minor adaptations are made to accommodate what are seen to be provincial peculiarities. Sometimes the current edition of the NBC is in force, sometimes it is earlier editions. Subsequent revisions to the NBC may or may not be adopted automatically.

With the release recently of the 1985 edition, the earlier codes typically remain in effect until the appropriate jurisdiction officially adopts the new version. Since Ontario only adopted its current building code in 1983 and Quebec modified its building code in April 1984, both based on the 1980 NBC, it is not clear how much time may elapse in those two provinces before conformance with the new requirements will be required. It appears likely that the 1985 NBC will be adopted by all other jurisdictions by early 1986.

In provinces which require municipalities to adopt the NBC, rural areas have no building code in effect and therefore no permits or inspections are needed. Since enforcement of the code usually falls under local jurisdiction, different municipalities may have different interpretations particularly as to whether or not retrofit installations come under the scope of the regulations.

National Fire Code

While the National Building Code deals with safe construction practices -- both new and retrofit -- the National Fire Code establishes the standard for fire prevention and safe operation. The NFC does not mandate combustion air requirements other than to reference the National Building Code for the installation of fuel-burning appliances. In some jurisdictions, a fire marshall may review plans or inspect heating installations for fire safety and compliance with the Fire Code.

Jurisdictions

Some provinces provide separate legislation to handle fuel or fire safety. Thus, the building code may be enforced by one agency while heating installations using oil or gas -- because they deal with fuel safety -- may be enforced by another agency.

In Ontario, for example, the Ministry of Consumer and Commercial Relations is responsible for fuel safety and has field inspectors who can be called to inspect faulty installations. The provincial building code, however, is the responsibility of the Ministry of

Housing, although permits and inspections are handled at the municipal or township level.

In some jurisdictions, the utilities may handle their own inspections (electricity and gas in Ontario, for example). In these cases, the necessary permits and inspections are obtained from the utility rather than from the provincial or local authorities.

In larger municipalities, permits and inspections tend to be organized along the lines of construction trades and some cities even make use of a heating inspector. At the other extreme, smaller localities may make use of part-time inspectors with little training or experience, unsure of their judgment and uncertain of their liability.

1.5 Government Programs

The most specific requirements related to combustion air supply are found in EMR's R2000 program. This demonstration program, in operation since 1981, is intended to give the Canadian residential construction industry experience in building energy-efficient houses, with energy loads 75 percent lower than their "built-to-code" counterparts.

The R2000 program requirements were revised in August 1984, even more stringent requirements went into place during 1985, and a further reassessment is expected in 1986. Even with the present regulations, naturally aspirating equipment -- that is, appliances which passively draw their combustion air supply from the surrounding space without mechanical assistance -- is not permitted.

The R2000 program appears to represent the lead in addressing the issues of supplying combustion air requirements in tightly constructed houses in Canada.

The purpose of this report was to review combustion air codes and standards relating to the residential use of solid, liquid, and gaseous fuel-burning equipment, with the following objectives:

- to compare and contrast the various code and standard requirements;
- to determine the technical basis on which they were developed and to procure any relevant documents;
- to determine whether they are applied to new and/or retrofitted equipment and buildings;
- to ascertain the extent of compliance in the field; and
- to determine any current activity on modification of the codes and standards.

Standards for combustion equipment in mobile homes were included, in addition to those for houses.

The purpose of the study was to allow Energy, Mines and Resources Canada to ascertain the current status of combustion air codes and standards, to enable them to develop strategies for improving code requirements and to assure that guidelines provided to air-sealing contractors do not violate combustion air supply codes.

To meet the objectives of this study, the relevant codes and standards were collected and reviewed. The review included the National Building Code plus Canadian Standard Association and Canadian Gas Association appliance standards and installation codes relating to housing and to mobile homes. Photocopies of the appropriate passages from these documents have been included in Appendix A.

Interviews, in person or by telephone, were conducted with code authorities and industry representatives to collect information on code application, local interpretations, the technical basis for the requirements, and the level of adherence. Information was also gathered on possible changes to the existing codes and standards.

Work on standards for northern housing and for an air-sealing manuals, although still in the preliminary stage, was also examined. Photocopies of the appropiate passages from a draft of the "Northern Measures" and related documents are included in Appendix B.

Appendix A and B together constitute the Bibliography in the form of photocopies of the documents cited, rather than a simple listing of publication data.

A list of the organizations contacted is presented in Appendix C. Documentation of interviews with provincial code officials is provided in Appendix D.

The regulations for the installation of fuel-burning appliances in houses are found in the National Building Code (NBC), which also references additional installation codes. The current edition of the NBC is 1985, now in the process of being adopted by the appropriate jurisdictions across the country.

Because the 1980 NBC is still in force in much of the country and because there are several differences between requirements in the two editions, each is discussed separately in this chapter.

The National Building Code covers new construction and alterations to existing buildings, but the issue of whether or not any specific renovation is covered by the code is decided by the local jurisdiction.

Regulations for combustion equipment in mobile homes are produced by several agencies, depending on the fuel used. Oil-fired equipment is covered by CSA standards, gas-fired equipment is covered by CGA standards, solid-fuel-fired equipment is covered by CSA standards, and factory-built fireplaces are covered by a ULC standard.

4.1 1980 National Building Code

The 1980 National Building Code contains its own general requirements for the supply of combustion air to fuel-fired equipment and additionally specifies Canadian Standards Association and Canadian Gas Association standards for the installation of oil-fired and gas-fired appliances.

No solid-fuel installation standard was in place in 1980 and so these devices were required to be installed in conformance with Part 6 of the NBC to meet the standards for non-residential solid-fuel-fired boilers and furnaces.

Part 9 of the NBC provides the requirements for houses and small buildings up to 600 m^2 -- just under 6,500 square feet. A photocopy of the appropriate sections of Part 9 is included in the Appendix.

The Part 9 provisions combined with additional requirements for durability and performance make up Residential Standards used by Canada Mortgage and Housing Corporation (CMHC) to govern construction under the National Housing Act. Thus buildings under CMHC jurisdiction are covered by the National Building Code through Residential Standards, even in local jurisdictions that have not adopted the NBC. The current edition of Residential Standards is based on the 1980 NBC.

Fireplaces

There are no combustion air requirements for fireplaces in the 1980 NBC. The section on fireplaces, 9.22, makes no reference to air supply.

Fuel-fired appliances

The first specific requirement for combustion air in the 1980 NBC is located in 9.33 Ventilation. According to Article 9.33.2.2:

A space that contains a fuel-fired heating appliance shall have natural or mechanical means of supplying the required combustion air.

In houses which are not judged to be "tight," infiltration appears to be considered adequate to meet this requirement.

Section 9.34 Heating and Air Conditioning includes cooking appliances and heating systems under 120 kW. A general caveat is given in Article 9.34.2.1:

The design, including heat loss and heat gain calculations, for the construction and installation of heating and air-conditioning systems, shall conform to good engineering practice such as the procedures described in the ASHRAE Guide and Data Books, the ASHRAE Handbooks, the HRA Digest and the Hydronics Institute Manuals.

Oil and gas equipment

The requirements for oil-burning and gas-burning equipment installations are spelled out in Article 9.34.2.3 in which conformance to the following standards is required:

CSA B139-1976, "Installation Code for Oil-Burning Equipment,"

CAN1-B149, 1-78, "Installation Code for Natural Gas Burning Appliances and Equipment"

CAN1-B149.2-78, "Installation Code for Propane Burning Appliances and Equipment."

Once a year, after discussions with the various subcommittees, NBC officials issue a list of revisions, including the latest editions of these standards, which then automatically go into effect. The current supplements or revisions to these three standards are presently:

CSA B139S1-1982 for oil-fired equipment,
CAN1-B149.1, M.80 for natural gas equipment, and
CAN1-B149.2, M.80 for propane equipment.

Solid-Fuel Appliances

Article 9.34.2.4 requires all solid-fuel-fired appliances, except fireplaces, to conform to Part 6, Heating, Ventilating and Air-Conditioning.

Part 6 includes repairs, adjustments or component replacements that change the capacity or safety of an existing HVAC system and that alter the method of operation. Part 6 normally does not cover low-rise residential and buildings under 600 m^2.

This section also requires that design, construction and installation conform to good engineering practice, such as ASHRAE. A photocopy of the appropriate passages in Part 6 is included in the Appendix.

The most specific requirements for combustion air supply are found in Subsection 6.2.5: Boilers and Furnaces Using Solid Fuel. All solid-fuel-fired equipment is to be installed in a room or space with sufficient accessibility for services, with specified clearances, and according to Article 6.2.5.1.(2).(b) with:

a permanent opening or openings providing an area of at least 3.3 mm^2/W input, connecting with the outdoors or with some space that freely connects with the outdoors. (See Appendix A.)

Appendix A contains explanatory material and is not a mandatory part of the NBC. It contains the following clause:

Clause 6.2.5.1.(2)(b) Air Openings for Combustion and Ventilation

Boiler or furnace room openings for outside air intake are necessary for combustion air and draft requirements. It may be necessary to increase the proportion of required openings to provide ventilation air for the boiler or furnace rooms. In any event, the combustion and ventilation air must not be drawn from an adjoining room or space separated from the boiler or furnace room by a fire door or other door that may become closed, either accidentally or purposely, as in a fire emergency. (See the following table.)

Sentence 6.2.5.1.(2) AIR OPENINGS FOR COMBUSTION AND VENTILATION FOR INSTALLATIONS NOT EXCEEDING 120 kW IN ANY ONE ENCLOSURE

Appliance Location	Area of Openings Required Based on Total Input Rating of all Appliances in Enclosure		
	Oil Fired Appliances	Propane and Natural Gas Fired Appliances	Solid Fuel Fired Appliances
Unconfined space with average construction	None required	None required when natural infiltration provides adequate combustion air and safe ambient air temperatures	3 300 mm^2/kW
Unconfined space with tight construction	440 mm^2/kW(1)	440 mm^2/kW	3 300 mm^2/kW
Confined space supplied by air within the building	2 openings each at least 2 200 mm^2/kW	2 openings each at least 2 200 mm^2/kW	3 300 mm^2/kW
Confined space supplied by air from outdoors either directly or by means of vertical ducts	2 openings each at least 550 mm^2/kW	2 openings each at least 550 mm^2/kW	3 300 mm^2/kW
Confined space supplied by air from outdoors by means of horizontal ducts	2 openings each at least 1 100 mm^2/kW	2 openings each at least 1 100 mm^2/kW	3 300 mm^2/kW
Confined space with ventilation air supplied from inside the building and combustion air from outdoors	2 openings each at least 2 200 mm^2/kW and 1 opening at least 440 mm^2/kW		3 300 mm^2/kW
Column 1	2	3	4

Note to Table:

(1) Includes the area of opening allowed for normal infiltration. (See also Article 9.34.2.1.)

[Article 9.34.2.1 requires conformation "to good engineering practice."]

Technical Basis for 1980 NBC Requirements

The general requirements in the 1980 NBC -- that combustion air must be supplied and that the installation must follow good engineering practice -- appear to be based on experience and common sense rather than on technical grounds.

According to a Canadian combustion engineer, the ASHRAE and other references for what constitutes good engineering practice only deal with the calculations for theoretical combustion air requirements and do not deal with how that air is actually supplied to the appliance. ASHRAE's publication 1980 Fundamentals is discussed later in this report under Section 5.3.

The source of the requirement in Part 6 for solid-fuel furnaces to be installed in a room with an opening to the outdoors of at least 3.3 mm^2/W input is unknown. This requirement is found at least as far back as the 1970 edition of the NBC. A code official said the number is "ancient," that no one in his office had been around long enough to remember, and that it was probably based on experience.

A combustion engineer said that the 3.3 mm^2/W input figure is "ridiculously large, was pulled out of a hat, and errs on the side of caution." He said that if this requirement is followed it would make more sense simply to build leaky houses. For a typical residential installation he estimated that this requirement would amount to about 1 square foot, an opening that any sensible homeowner would block up.

The openings suggested for combustion and ventilation air supply openings in Table 6.2.5.1.(2) were simply transcribed from the specified oil and gas installation standards and from the 3.3 mm^2/W figure for solid fuels.

4.2 1985 National Building Code

The 1985 edition of the National Building Code contains a number of changes over the current code relating to combustion appliances. The most recent version of CSA and CGA are specified for oil and gas installations and the new CSA B365-1984 standard is specified in

Part 6 for the installation of solid-fuel central heating appliances. Space heaters are regulated under Part 9. A number of requirements that duplicate B365 have been deleted.

Copies of the appropriate pages of the 1985 NBC are included in Appendix A.

Make-up Air

Subsection 9.33.3 of the new edition, Mechanical Ventilation, requires that dwelling units have a mechanical ventilation system capable of providing at least one half an air change per hour during the heating season. Article 9.33.3.3 contains a further requirement:

Mechanical ventilation systems for dwelling units shall include provision for introduction of fresh make-up air from the exterior.

Note that no heat recovery is called for; the terms are sufficiently loose that an exhaust fan and a passive inlet could meet the requirement.

Fireplaces

Under Section 9.22 Fireplaces, Article 9.22.1.4 says:

Fireplaces, including factory-built fireplaces, shall have a supply of combustion air in accordance with Article 9.34.2.3.

(Article 9.34.2.3. requires complete venting of combustion products to the outside of the building.)

Fuel-fired Appliances

Under Section 9.33 Ventilation, Article 9.33.1.6 says:

A space that contains a fuel-fired heating appliances shall be provided with combustion air in accordance with Section 9.34.

Section 9.34 Heating and Air-Conditioning requires the design and installation of central heating systems to conform to the requirements of Part 6 as well as to Part 9. Part 6 will no longer contain any specified opening sizes and will rely on the fuel-specific installation standards to provide those figures. Solid-fuel add-ons will not be permitted unless proven safe.

Compensation air

Article 9.34.2.3, which includes stoves, ranges, space heaters and fireplaces, says:

Solid fuel-burning appliances shall be installed in a manner that ensures the complete venting of the products of combustion to the outside air. Compensation shall be made for the air drawn by other appliances or exhaust equipment. (See Appendix A.)

Appendix A contains Article A-9.34.2.3 which explains:

The operation of an air exhaust system or of a fuel-burning appliance removes the air from a house, creating a slight negative pressure inside. In certain cases, the natural flow of air up a chimney can be reversed, leading to a possible danger of carbon monoxide poisoning for the inhabitants.

Newer houses are generally more tightly constructed than older ones because of improved construction practices, including tighter windows, weather stripping and caulking. This fact increases the probability that infiltration may not be able to supply enough air to compensate for simultaneous operation of exhaust fans, fireplaces, clothes dryers, furnaces and space heaters.

Further information is available in Canadian Building Digest 222, "Airtight Houses and Carbon Monoxide Poisoning," available from the Division of Building Research, National Research Council of Canada, Ottawa K1A 0R6.

CBD 222

A copy of CBD 222, written in 1982, is included in Appendix B. It describes the problem of exhaust equipment creating a negative pressure and the possible reversing of flow within the chimney.

It cites records showing that annually about 10 people die and about 100 people receive hospital in-patient treatment as a result of carbon monoxide poisoning attributed to the incomplete combustion of domestic fuel, although it says that the records do not establish a direct connection between the CO problem and inadequate air supply or venting failure of the furnace chimney.

CBD 222 also describes the analysis undertaken to determine to what extent carbon monoxide poisoning could be related to airtightness and concludes that "the supply of an adequate amount of outside air should be considered for all fuel-burning appliances." It does not say how this consideration is to be undertaken.

* * * * * *

Installation Codes

The most recent versions of the fuel-specific standards specified in the 1985 NBC are discussed in the following section -- B139 for oil-fired equipment installations, B149 for gas-fired installations, and B365 for solid-fuel-fired installations. None of these codes distinguish between new and retrofit installations -- they cover all installations.

TABLE 1 OPENINGS FOR COMBUSTION AIR SUPPLY BY FUEL - RESIDENTIAL INSTALLATIONS
(Most Recent Edition of Each Code, as Specified in 1985 National Building Code)

Appliance Location	B139-1976 (S1-1982) Oil-fired	B149- M.80* Gas-fired	B365-1984 Solid-fuel-fired
Unconfined space with average construction	None required	None required if infiltration supplies sufficient air for combustion, venting and ventilation	None required if infiltration supplies sufficient air for combustion and ventilation
Unconfined space with tight construction	1 in.^{2} per 5000 Btuh including infiltration	1 in.^{2} per 5000 Btuh (450 mm^2/kW)	
Confined space supplied by air within the building	2 openings each at least 1 in.^{2} per 1000 Btuh	2 openings each at least 1 in.^{2} per 1000 Btuh (2225 mm^2/kW)	at least 3.3 mm^2/W (1-1/2 in.^{2}/Btuh); ducts not less than 11000 mm^2 (17 in.^{2}), not more than 3 m long, max. 2-90° elbows
Confined space supplied by air from outdoors either directly or by vertical ducts	2 openings at least 1 in.^{2} per 4000 Btuh	2 openings at least 1 in.^{2} per 4000 Btuh (500 mm^2/kW)	at least 3.3 mm^2/W (1-1/2 in.^{2}/Btuh); ducts not less than 11000 mm^2 (17 in.^{2}), not more than 3 m long, max. 2-90° elbows
Confined space supplied by air from outdoors by horizontal ducts	2 openings at least 1 in.^{2} per 2000 Btuh	2 openings at least 1 in.^{2} per 2000 Btuh (1100 mm^2/kW)	at least 3.3 mm^2/W (1-1/2 in.^{2}/Btuh); ducts not less than 11000 mm^2 (17 in.^{2}), not more than 3 m long, max. 2-90° elbows
Confined space with ventilation air supplied from indoors and combustion air from outdoors	2 ventilation openings plus at least 1 in.^{2} per 5000 Btuh	Ventilation opening plus at least 1 in.^{2} per 5000 Btuh (450 mm^2/kW)	at least 3.3 mm^2/W (1-1/2 in.^{2}/Btuh); ducts not less than 11000 mm^2 (17 in.^{2}), not more than 3 m long, max. 2-90° elbows

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(* B149 has been revised and will be issued as B149-M86 in early 1986)

4.3 Oil-Fired Installations -- B139

The National Building Code specifies Canadian Standards Association code B139-1976 for the installation of oil-fired appliances. A photocopy of the appropriate pages is included in Appendix A. A supplement to this code was issued in 1982 with no additional reference to combustion air requirements.

B139 requires that "sufficient air for combustion" must be supplied to the space containing the equipment, and refers to the appendix for further information.

Section 4.3, Air for Combustion and Ventilation also states the requirement for "an adequate supply of combustion air" and requires provision to be made to compensate for air "drawn from the area by other appliances", but it does not explain how this compensation is to be achieved.

In houses where normal infiltration does not meet the requirements for combustion air and ventilation, outside air must be introduced, and those ducts are required to have a cross-sectional area at least equal to the openings, with a minimum dimension of 3 inches.

The section specifying tests contains five tests for proper combustion (draft, smoke density, temperature and analysis of flue gases), although there are no specific requirements to check for compensating air supply.

Appendix A, not a mandatory part of the installation code, divides the requirements into two parts, one for confined spaces and the other for unconfined spaces. Neither term is defined.

The following articles apply to unconfined spaces:

A2.1 In unconfined spaces in buildings of conventional frame, brick or stone construction, infiltration normally is adequate to provide air for combustion and ventilation.

A2.2 If the unconfined space is within a building having insufficient air because of tight construction, additional air for combustion and ventilation should be obtained from outdoors or from spaces freely communicating with the outdoors. Under these conditions, permanent openings should be provided so that the total air received through them and by infiltration will be at least equal to that which would be admitted by openings having a total free area of 1 square inch per 5,000 Btu/h (28 square inches per (U.S.) gallon per hour) of total input rating of all appliances.

For appliances located in confined areas, more detailed requirements apply:

A3.1 All Air From Inside Building. The confined space should be provided with two permanent openings, one near the top of the enclosure and one near the bottom. Each opening should have a free area of not less than 1 square inch per 1,000 Btu/h (140 square inches per (U.S.) gallon per hour) of the total input rating of all appliances in the enclosure, freely communicating with interior areas having in turn adequate infiltration from the outside.

A3.2 All Air From Outdoors

A3.2.1 The confined space should be provided with two permanent openings, one in or near the top of the enclosure and one in or near the bottom. The openings should communicate directly, or by means of ducts, with outdoors or to such spaces (crawl or attic), that freely communicate with outdoors.

Illustrations are provided to show the concepts.

The appendix goes on to require that if the ducts are vertical, each opening should have a free area of not less than 1 square inch per 4,000 Btu/h input, but if the ducts are horizontal the openings should be at least 1 square inch per 2,000 Btu/h. If the openings connect directly to the outdoors the requirement for 1 square inch per 4,000 Btu/h is acceptable. If the confined space receives ventilation air from inside the building and combustion air from outdoors, the ventilation part of the requirement is the same as for installations with all air from indoors -- two openings of 1 square inch per 1,000 Btu/h input -- plus a single opening to the outdoors (or spaces open to the outdoors) of 1 square inch per 5,000 Btu/h input.

Ducts for make-up air may be connected to the cold air return only if they connect directly to outdoor air.

Specially engineered installations do not need to meet these requirements provided that they are approved by the local authority.

Technical Basis for B139

According to the secretary of the standard-writing committee, the figures on opening size requirements were contributed by industry members -- by designers and practitioners. The fact that opening sizes are given for firing rates in U.S. gallons-per-hour suggests either that an American model was followed or that Canadian products are calibrated in U.S. measures. Apparently the latter is true, and even European products in Canada are calibrated in U.S. gallons.

A combustion engineer interviewed for this study said that the 1 $inch^2$ per 5000 Btuh input is a "reasonable" figure. He offered the opinion that the number was simply a consensus as to what was reasonable and he added that although there is a good technical basis for approximately that size there is no basis for the exact size specified.

He could not understand why there was a different requirement for horizontal and vertical ducting.

Originally it was a guess that the flow-rates would be different, he supposed, and the requirement was simply copied ever since. He pointed out that the code makes no reference to elbows in the ducting nor to total duct length.

An industry spokesman indicated that oil-fired installations tend not to follow the code requirements as closely as gas installations and, he added, the regulations tend not to be enforced by the inspectors as rigidly.

Changes to B139

A spokesman for CSA indicated that the committee which drafts this code has been inactive since the 1982 supplement was issued. Plans call for the committee to convene soon, although no specific date has yet been established, to address various parts of the standard that require updating.

4.4 Gas-Fired Installations - B149

The National Building Code specifies Canadian Gas Association codes for the installation of natural gas and propane appliances. The current version of this code is B149-1980. A photocopy of the appropriate pages is included in the Appendix.

The first edition of this installation code was published in 1958 by the Canadian Standards Association. Following publication of the 1966 edition, the code was split into two parts, B149.1 for natural gas installations and B149.2 for propane installations. With the exception of sections covering supply and storage of propane, the two codes are essentially the same and referred to in this report simply as B149.

In 1974 the Canadian Gas Association (CGA) took over responsibility for the standard, and produced new editions in 1976, 1978, and 1980. Changes to the 1980 version have been finalized and the new edition, designated B149-M86, is expected early in 1986.

Sufficient Air

Section 6 of B149 deals with air for combustion, venting and ventilation. This section requires an appliance to be installed in a location where there is sufficient supply for combustion air, venting, and ventilation air and specifies that when a building is so tightly sealed that infiltration does not meet the air supply requirement, outside air supply shall be provided.

Ducts

Ducts used to supply air from the outdoors must be metal or other non-combustible material and have the same cross-sectional area as the free area of the opening to which they connect. The smaller dimension of a rectangular duct cannot be less than 75 mm (3 inches). For natural draft or fan-assisted burners, the bottom of the air supply opening must be between 150-450 mm (6-18 inches) above the floor.

Installer responsibility

No test or procedure is required to determine whether or not natural infiltration is sufficient for combustion and other exhaust air, nor are the terms "tight construction," "confined spaces" or "unconfined spaces" defined. However B149 does specify:

6.1.6 Responsibility for proper and adequate venting of all types of appliances shall rest with the installer.

Opening sizes

The specific requirements for installations depend on whether the appliances are located in a confined or unconfined space and whether the installer decides if the building is tight -- that is, having insufficient infiltration for combustion, dilution, and other exhaust air.

If the gas appliances are located in an unconfined space in a tight building, Section 6.2.1 applies -- the air supply must be obtained from outdoors through an opening with a free area of at least 1 inch^2 per 5000 Btuh (450 mm^2 per kW) of the total input rating of all appliances in that space. This opening may be connected to the cold air return.

If appliances are located in a confined space in a loose building, Section 6.3.1 applies -- there must be two permanent openings to the interior. The lower opening must be between 6-18 inches above the floor and have a free opening of at least 1 inch^2 per 1000 Btuh (2225 mm^2 per kW) of the total input ratings. The upper opening must be as near the ceiling as possible and above the draft hood or regulator and be at least as large as the chimney. In closet installations, the upper opening must be as large as the lower opening.

When the appliance is in a confined space and the air is from outdoors, Section 6.3.2 applies -- the lower opening must be 6-18 inches off the floor and have an opening of:

(i)1 inch^2 per 2000 Btuh (1100 mm^2 per kW) of the total input rating of all appliances in the space when communication with outdoors is by means of a horizontal duct or,

(ii)1 inch^2 per 4000 Btuh (500 mm^2 per kW) of the total input rating of all appliances in the space when communications with outdoors is directly by an opening or by means or [sic] **a vertical duct and,**

the upper opening must meet the same requirements as before.

When appliances are located in a confined space and the ventilation air is from inside the building and the combustion and draft hood dilution air supply is from outdoors, Section 6.3.3 applies -- the previous upper opening requirement is needed for ventilation air plus:

one permanent air supply opening shall be provided for combustion and draft hood dilution air that communicates directly with outdoors. This opening shall have a free area of not less than 1 inch^2 per 5000 Btuh (450 mm^2 per kW) of the total input rating of all appliances in the confined space and may be connected to the cold air return of a heating system.

B149 goes on to require that the free area for the air supply duct be calculated by subtracting the blockage area of louvres, grills or screens and specifies a minimum dimension of 0.25 inches (6 mm) between those apertures. Manual dampers are not allowed but automatic ones are, provided that they are interlocked so that the main burner cannot operate unless the damper is fully open.

Compensation air

The issue of compensation air is covered in Section 6.5:

6.5 Conditions Created by Exhaust Fans or Fireplaces

6.5.1 When operation of an exhaust fan, a clothes dryer, a kitchen exhaust system or a fireplace may create a condition causing unsatisfactory combustion or venting of an appliance, provisions shall be made to overcome such conditions and shall be subject to the approval of the enforcing authority.

All supply air requirements may be changed in an engineered installation, subject to the approval of the enforcing authority.

Exceptions apply if the air is supplied by mechanical means, in which case an air-flow sensing device must be installed and wired into the safety limit circuit of the primary safety control to shut off the gas in the event of air supply failure. If there is no combustion safety control, the gas supply must be manually restored.

If the air supply is provided by a make-up air heater which is interlocked with the appliance, none of the specific requirements in the code apply.

Technical Basis for B149

The regulations in B149 for which some technical basis was sought are those relating to the size of duct openings relative to appliance energy input, the height of the opening off the floor, and the definition of a confined space.

The technical basis for these regulations is unknown to the current secretary of the CGA's B149 Installation Code Committee, who suggested that the figures may have come from Z223.1, the National Fuel Gas Code used in the United States.

U.S. National Fuel Gas Code

It is not clear if B149 is based on the U.S. equivalent. That code has some minimum sizes for ducts -- 100 square inches -- and the heights are different, with one commencing 12 inches from the ceiling and the other 12 inches from the floor. Other than that, the duct sizing requirements per heat input are the same. Illustrations in the CGA's Canadian Gas Appliance Installation Manual are copies of those in the U.S. Code, so it appears that the U.S. influence is strong.

Photocopies of the relevant passages from the U.S. code are included in Appendix B for comparison purposes.

According to the secretary of the U.S. code committee, the requirements "go back many years," probably to the 1950's. The definition for confined spaces -- those with a volume of less than 50 cubic feet per 1000 Btu/h input capacity -- dates from 1973 and was based on an assumed standard construction infiltration rate of 1/2 air change per hour, with a slight margin of safety.

The issue of compensation air supply is covered in the U.S. code by stating that fireplaces and exhaust appliances in tight houses "may create conditions requiring special attention" to avoid unsatisfactory operation of exhaust equipment.

Canadian basis

A National Research Council scientist who used to sit on the Canadian committee couldn't recall the technical basis of the requirements but suggested that they came either from rules of thumb used by Canadian gas utilities or were based on the U.S. version.

A spokesman for Consumers Gas, who is also the chairman of the code's ventilation committee, said that the minimum height above the floor for the ducts was arbitrarily chosen at 6 inches to prevent installers from running the duct to the floor, thus reducing the effective area, and a maximum of 18 inches to ensure that it remained below the draft hood.

A combustion engineer, when shown the gas code requirements, could not understand why vertical ducts and direct connections require half the area of horizontal ducts and suggested that there is "not the slightest difference" in an appliance's ability to draw its air supply from different directions. The requirement for 1 inch^2 per 5000 Btuh input, whatever the installation's location, is more reasonable than the others, he added.

Possible Changes to B149

A new edition of B149 is expected to be released in early 1986. For the past two years a Subcommittee on Ventilation and Combustion Air has been discussing the matter, and several recommendations were considered. Changes to the 1980 edition have now been finalized. Once the new edition is released, enforcement of the new requirements will be the responsibility of the provincial gas inspection authorities who adopt the B149 code through legislation.

Duct sizes

Changes have been made to reduce the opening sizes for combustion air ducts. These reductions likely resulted from field experience showing that homeowners frequently block off the air supply ducts in an effort to reduce chilling of the furnace room. Since this reduced size does not appear to alter the operation of the appliances, the earlier duct sizes are agreed to be larger than necessary. The new edition of B149 will also require the smaller outside air supply duct to terminate at a specified distance in close proximity to the burner.

Confined Spaces

The Subcommittee had earlier ratified a new definition of what constitutes a "confined space," but the change did not go through as the new edition drops the distinction between confined and unconfined spaces and relies instead on a new requirement related to Equivalent Leakage Area (ELA) or type of construction.

Under the Subcommittee's proposed definition, any space with a volume of less than 50 cubic feet per 1000 Btuh of appliance input would have been considered a "confined space" and any space with a larger volume would have been considered an "unconfined space." This is the same definition as the U.S. code uses.

(Officials with the SEEH/R-2000 program were concerned with this definition and its interpretation by building inspectors. They said that it assumes a natural 0.25 air change per hour rate and they point out that other factors, such as exhaust appliances and pressure zones, need to be considered. Because R-2000 houses have natural air leakage rates substantially less than 0.25 air changes per hour and because of the down-sized furnaces being used in tight, well-insulated SEEH houses, the proposed definition for confined spaces only works for conventional houses. Besides, they add, who does the calculations and what are the implications of the homeowner making future modifications to the space? Given this situation, the R-2000 program requires all R-2000 houses to have outside air supply and guidelines are being established for the correct procedures.)

Direct air supply

The Subcommittee was also considering whether to make it mandatory for appliances to have a direct air supply or be located in a room isolated from the rest of the living space. A position paper by the CGA Certification Division was presented to the Subcommittee in May 1983 recommending this approach but it does not necessarily represent the industry-wide point of view. Concern had been expressed that the recommendations were not practical since they can only apply to new products specifically designed for that application. A photocopy of this discussion paper is included in Appendix B; its conclusions are based on field observations and not on any documented testing.

No changes were made in this regard to the new edition of B149.

Tight Construction

According to the secretary to the B149 Committee, the new edition of the code will require that an outdoor air supply be provided to a central heating furnace, boiler, or hot water heater if the structure in which the appliance is installed is either of "tight construction" or has an ELA of 78 square inches ($0.05\ m^2$) or less, as determined by a fan depressurization test at a 10 Pa differential test pressure. For appliances having draft control devices, an air supply sizing criteria of 1 square inch per 14,000 Btuh input will apply. In addition, the termination of the air supply duct in relation to the appliance will be specified.

The definition of "tight construction" will be a structure which has windows and doors of close fitting or sealed construction and the exterior walls are covered by a continuous sealed vapour barrier and either gypsum wallboard (drywall), plywood or similar materials having sealed joints.

If the structure is not of tight construction or does not have an ELA of less than 78 square inches at the specified pressure differential, then an outdoor air supply may or may not be required, depending on the volume of the structure or enclosure. Sizing tables will be provided which will indicate to the installer the necessary air supply requirements.

When these requirements were being discussed at the Committee stage, concern arising implementation of the 0.05 m^2 ELA as the definition of a "tight" structure prompted an investigation of that figure.[1] The result of that investigation indicated that while the figure had not specifically been originated for use in combustion air requirements analysis, there was no reason to adopt any other figure. It recommended the adoption of 0.05 m^2 at 10 Pa as the definition of the critical air tightness value, provided that it is procured only by the recognized Canadian fan depressurization test procedure (CAN2-149.10-M85 "Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method").

4.5 Solid-Fuel-Fired Installations -- B365

The 1985 National Building Code specifies CSA B365 for the installation of solid-fuel-fired central heating appliances. B365 was first released in 1980 and ran into some difficulties. It was redrafted and released in 1982, and was redrafted and released again in November 1984. Photocopies of the appropriate pages of B365-1984 are included in Appendix A.

A member of the committee pointed out that although these codes are labelled "solid-fuel", they were written primarily for wood-fired units as there is virtually no Canadian market for residential coal-fired units.

Section 4 in B365 covers Air for Combustion and Ventilation. Appliances must be located so as not to interfere with circulation of air for combustion and ventilation, and if normal infiltration is insufficient outside air must be introduced in the same way as for furnaces and boilers.

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[1] "Investigation of a Tight Structure as Proposed by the B149 Committee," by R.J. Brintnell, Energy Utilization and Development, Union Gas Ltd., August 1985, 6 pages plus appendices.

The following two notes to Section 4.2 explain that:

(1) The minimum size of openings may be determined by trial and error to accommodate the flue characteristics, the firing rate, the building characteristics etc. As a guide, the combustion air opening should be 0.5 times the flue collar area.

(2) A solid fuel burning appliance should be installed only where

(a)ambient air temperatures are maintained within acceptable operating limits;

(b)provision is made to compensate for the air drawn from the area by other appliances such as exhaust fans, clothes dryers, or fireplaces.

Spaces with boilers and furnaces, plus other appliances in tight houses, are required to have a permanent opening with an area of 3.3 mm^2/W (1.5 in^2/1000 Btu/h) input, connected either to the outdoors, to an outdoor-connected space, or a space "that allows sufficient infiltration from outdoors."

Outdoor air ducts are required to be at least 11,000 mm^2 (17 in^2) in area, no longer than 3 m (or the engineering equivalent), and with no more than two 90° elbows. Automatic dampers must be interlocked to prevent the unit being fired before the damper is open.

Technical Basis for B365

A technical consultant to the Canadian Wood Energy Institute believes that the raw data exists in the form of velocity and flow rates and the total combustion air requirements, but that the necessary calculations have not been done. The requirements appear to be based on experience within the industry, but the original source for the 3.3 mm^2/W input is unknown; this figure was probably simply transcribed from the 1980 NBC even though it is not found in the 1985 edition.

A combustion engineer said that the figure of a combustion air opening of 0.5 times the flue collar area is a rule-of-thumb based on the idea that larger appliances will have larger flue collars and on the obvious fact that there is no need to supply more air going into the appliance than is exhausted up the flue.

During their product testing, manufacturers find that if the flue opening is too small the appliances will smoke and therefore they always err on the large side to avoid smoking problems. This trial-and-error method, one source pointed out, works well with oil and wood but not with gas where dropping below the minimum size will not produce obvious smoke even though it will produce carbon monoxide.

The B365 requirements for combustion air duct sizing are not related to the heat capacity (and therefore air demand) and simply translate as calling for a minimum duct diameter of four inches -- exactly 0.5 times the maximum flue collar diameter of eight inches.

Reasonable ambient air temperatures are not based on combustion air requirements but are required because the appliances are tested at room temperatures and concerns have been expressed that components such as fans and motors may not function at colder temperatures.

The requirement for compensation (or make up) air appears to be inserted as a warning flag, as no specific solution is required and no test for compliance is indicated.

Changes to B365

This is a brand-new code. The committee is still active, however, and is working on further revisions to the standard.

A task force dealing with combustion air for space heaters has been formed and has submitted recommendations, but these deal specifically with the issue of whether central systems should allow manual burning rate controls as well as thermostats. As is the case with other codes, committees dealing with combustion air only addressed the opening at the appliance itself.

4.6 B366 Solid-Fuel-Fired Equipment

A separate code, B366, a product safety standard covering solid-fuel appliances, is cited as a requirement within B365, the installation code. B366 comes in two volumes; Part 1 is a CSA-only code dealing with central systems, while Part 2 is a joint CSA-ULC code covering space heaters. Neither part covers fireplaces.

Both of the B366 codes contain requirements for equipment installed in houses, plus additional requirements for equipment installed in mobile homes. This section discusses only those requirements that apply to units used in houses; the requirements for mobile home installations are included in Section 4.7 Mobile Home Requirements.

Photocopies of the relevant pages from each B366 document are included in Appendix A.

CSA-B366.1-1981 Solid-Fuel-Fired Appliances for Residential Use (Central Systems)

Standard B366.1 contains a section on combustion air supply to these central system appliances used in houses, but the requirements describe only the operation of the air supply regulator on the unit itself.

Outdoor-Aired Systems

This standard also contains requirements for solid-fuel-fired outdoor-aired systems -- defined as appliances which draw all their combustion air directly from the outdoors -- intended for use in mobile homes. However, if these appliances are installed in conventional houses they are required to pass the same series of firing, wind and rain tests.

These outdoor-aired units are also required to provide automatic control of combustion air, drawn from the outdoors. The required components are to be provided and shipped with the appliance. Barometric draft controls are not allowed. An indicator showing the position of the combustion-air damper must be visible.

CSA-B366.2-M1984 (ULC-S627-M1984) Space Heaters for Use with Solid Fuels

Standard B366.2 is divided into two parts. Part A applies to these appliances in houses; Part B contains additional requirements for mobile homes.

Combustion Air Supply

In Part A, the first reference to combustion air supply refers to the operation of the regulator on the stove. Additional requirements apply if combustion air is supplied from outdoors.

6.8.1 Where a space heater is provided with combustion air (from outdoors), the supply ducts shall be at least as large in effective area as one-half of the

area of the flue, unless the duct is provided by the manufacturer as part of the unit.

Dampers allowing 100 percent closure must be provided in air intakes connected directly to the outdoors.

4.7 Mobile Home Requirements

This section reviews eight standards developed by CSA, CGA and ULC for combustion heating equipment in mobile homes. Photocopies of the relevant pages from these eight standards are included in Appendix A. Definitions and general requirements for mobile homes are contained in CSA-Z240.01-1981.

The term "mobile home" refers to a transportable, single or multiple-section single-family dwelling conforming at the time of their manufacture to the Z240 series of CSA standards. Mobile homes are ready for residential occupancy once they are set up according to factory-recommended procedures. They are complete structurally with the entire plumbing, electrical and heating services already installed.

Factory-built houses designed for installation on a permanent foundation are considered "manufactured homes" by CSA standard A277 and have to comply with the National Building Code whereas mobile homes are required to conform to the Z240 series. CSA A277 covers the procedure for certification of factory-built houses and describes a plant quality program that applies to plants producing factory-built houses and to those producing mobile homes.

Because of their small volume, relatively tight construction and low height with its smaller draft-driving force, the standards that apply to mobile homes are more restrictive than those applied to conventional housing.

TABLE 2 OPENINGS FOR COMBUSTION AIR SUPPLY BY FUEL -- MOBILE HOMES

Appliance	Code or Standard	Requirement
Oil-fired Air Systems - complete separation of combustion and indoor air	CSA B140.10-74/81	At least 1 inch^2 per 5,0000 Btuh input
Oil-fired Appliances - other than sealed combustion units	CSA Z240.5-1971	1 inch^2 per 2,000 Btuh input
Gas Appliances - non-direct vent	CSA Z240.4.1-83	Manufacturer's recommendations or 1100 mm^2 per kW input
- clothes dryers		Replacement air opening at least twice area of dryer exhaust
Gas Appliances - direct vent	CGA CAN1-2.19-M81	Sized by manufacturer and supplied as part of system
Gas Appliances - gravity and forced air furnaces with complete separation of combustion and indoor air	CGA CAN1-2.3-M84	Sized by manufacturer and supplied as part of system*
Solid-fuel Appliances - outdoor aired central systems	CSA B366.1-M81	Automatic control; supplied as part of system*
Solid-fuel Space Heaters	CSA B366.2-M84	At least one-half area of flue
Factory-built Fireplaces	ULC S610-M79	At least one-half area of flue**

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* This requirement applies to houses as well

** This requirement applies to houses as well, provided the unit is equipped with inlets.

CSA-B140.10-1974 Oil-Fired Warm Air Heating Appliances for Mobile Housing and Recreational Vehicles

Scope

Standard B140.10 applies to oil-burning, flue-connected forced-air appliances that provide complete separation of the combustion system, including the air for combustion, from the atmosphere of the living space in mobile homes. This standard applies regardless of the heating capacity or the type of burner used or the location of the fuel supply.

B140.10 was reaffirmed in 1981 so as to include any revisions that have been incorporated over the intervening years.

B140.10 contains requirements for general construction details, including access doors, removable panels through which combustion air is drawn, and air shutters. Exterior air intakes on the underside of the mobile home must extend at least one inch below the lowest point of the floor and those on the roof must extend at least six inches above the surface. Air intakes which extend through an outside wall must not project more than three inches. The entrance to all air intakes must exclude rain, snow, debris and birds.

Combustion Air Supply

Specific requirements for combustion air openings are given in Clause 4.16.8:

The free area of openings to the outdoors in combustion air and dilution air-intake assemblies to be installed in the wall of an enclosure in which an appliance is to be installed shall be not less than 1 square inch for each 5,000 Btuh of the total input rating of the appliance.

In the case of failure with automatic air controls or forced or induced draft fans, safe combustion or fuel shut-off must occur. Furnace operation must not be affected by such negative pressures as may be developed in the burner compartment due to such conditions as restricted air filters or returned circulating air supply.

Tests

These units are required to pass various performance tests to ensure safe and reliable operation including firing, wind and rain tests. For the wind test, the unit is to be tested in an enclosure simulating a mobile home, although a CSA spokesman says they now use an actual mobile home set up on concrete blocks behind the test centre. Winds are directed across the combustion air inlet and the vent outlet simultaneously at a variety of angles and directions at velocities fluctuated between 30 to 40 miles per hour and of 10 and 20 mph. The burner is required to ignite and operate reliably during this test.

CSA-Z240.5-1971 Oil Requirements for Mobile Housing and Recreational Vehicles

Standard Z240.5 applies to the factory installation of oil-fired appliances in mobile homes.

Combustion Air Supply

This standard contains specific requirements for fresh air for combustion for other than sealed-combustion systems in Section 6.1:

(a) By providing 1 square inch of free air passage for every 2,000 Btuh input; and

(b) Half of the required area shall be taken through the ceiling or within 18 inches therefrom and approximately one half shall be taken through the floor or 6 inches therefrom.

Section 6.2 contains requirements for combustion air for equipment other than heating and hot water appliances. It calls for one square inch of free air space for every 2,000 Btuh input of all such appliances not provided with complete separation of the combustion chamber. The vent opening must be a monitor vent or equivalent, with an adjacent warning label.

CSA-Z240.4.1-M1983 Installation Requirements for Gas Burning Appliances in Mobile Homes

Scope

This standard covers the factory installation of gas-burning appliances and equipment in mobile homes and includes specific requirements for accessibility, clearances and venting. B149, the installation code for gas appliances in houses, was used as the basis for developing this version for mobile home installations.

Combustion Air Supply

Section 6 covers air supply for furnaces and water heaters that are not direct vent appliances. Clause 6.1 calls for provisions to ensure a proper supply of fresh air for combustion and ventilation as follows:

(a) By providing adequate free air passage as recommended by the appliance manufacturer in accordance with the appliance certification;

(b) If no recommendation is provided by the appliance manufacturer, by providing 1100 mm^2 of free area per kW input;

(c) Approximately one-half of the required area shall be taken through the roof or within 450 mm therefrom, ensuring that no portion is below the relief opening of the draft hood. The remaining one-half shall be taken through the floor or 150 mm therefrom; and

(d) An entrance of an air intake assembly shall be guarded, shielded, or located to exclude rain, snow, debris, vermin, and birds. A screen, if used, shall have a mesh of not less than 6 mm.

Other arrangements for providing combustion air are permitted if certified for use with the appliance.

Combustion air for equipment other than furnaces and hot water appliances must be supplied by providing 1100 mm^2 of free area per kW input. These openings may be a monitor vent, other windows, or a roof-top ventilator; a warning label is required adjacent to the opening.

Replacement Air

This standard also contains a requirement for replacement air for gas-fired clothes dryers:

6.3 Provision for a supply of replacement air for gas-fired clothes dryers shall be provided in the area where the dryer is located, such opening being not less than twice the area of the dryer exhaust. A warning label as called for in Clause 6.2 shall be provided.

CAN1-2.19-M81 Gas-Fired Gravity and Fan Type Direct Vent Wall Furnaces

Scope

This Canadian Gas Association standard applies to newly produced automatically operated natural draft and fan-induced inlet-air direct vent wall furnaces with inputs up to 400,000 Btuh (117.23 kW), using natural gas or propane and installed in mobile homes and recreational vehicles. The appliance anticipated in the standard is essentially a balanced flue appliance with the air intake and vent outlet in close proximity. The 1981 standard is a revised version of a 1969 edition.

Requirements

The standard includes requirements for general construction features, burners and ignition devices, piping, controls and electrical equipment in addition to combustion and ventilation air.

Openings in panels over combustion air openings must be a minimum diameter of 1/8 inch (3.2 mm). When installed according to manufacturer's instructions, the combustion air supply must be in the same pressure zone as the vent outlet. The appliance must also be designed so that if the blower providing the draft fails, gas flow to the main burner must be prevented.

Other requirements apply to the vent and air intake pipes, which must be supplied as part of the system. Size is to be determined by the manufacturer and a number of specific requirements apply to joints, material, gauge and connections.

Tests

These systems are required to pass a variety of tests. In the wind test the gas at the pilot burner must be capable of being ignited when the vent/air intake terminal is exposed to a wind of 10 miles per hour (4.47 m/s). In the second part of the test, the main burner and pilot must not be extinguished and the pilot must be capable of igniting the main burner when the vent/air intake terminal is exposed to a wind of 40 mph (17.88 m/s).

The vent/air intake terminal is required to pass a direct loading test and an impact test. Diagrams showing how the tests are to be conducted are included in the standard.

CAN1-2.3-M84 Gas-Fired Gravity and Forced Air Central Furnaces

This Canadian Gas Association standard is a revised edition of a 1982 version. Although published in late 1984, this standard was not to go into effect until November 1985.

Scope

This standard applies to newly produced gas-fired gravity and forced-air furnaces for installation in residential, commercial, and industrial occupancies as well as in mobile housing and recreational vehicles. It applies to automatically operated units having inputs up to 400,000 Btuh (117.23 kW). Parts I and

II apply to building installations; Parts III and IV apply to mobile homes.

Residential Requirements

The standard includes requirements for construction features and performance tests. Vent and air-intake pipes are sized by the manufacturer and must be supplied with the appliance.

Direct vent appliances must have the vent/air intake system included as part of the furnace. When an automatic combustion air door is provided, the force of gravity must open the door in case the control becomes inoperative unless the door is connected to an automatic valve. Combustion air cannot be drawn from the circulating air stream. The top of concealed combustion air openings must be at least two inches above the floor and the bottom must not be less than one inch above the floor unless other requirements can be met.

When installed according to instructions, the combustion air supply must be in the same pressure zone as the draft hood relief opening, if one is equipped, and on direct vent furnaces the combustion air supply under static conditions must be in the same pressure zone as the vent outlet. Combustion air supply openings cannot be adjustable. On units with induced draft or power burners, gas flow to the main burner must be prevented if the blower fails. A number of performance tests are required.

Mobile Home Requirements

Other requirements apply when units are installed in mobile homes. According to Clause 3.1.4:

> **Furnaces shall be of a construction providing complete separation of the combustion system from the atmosphere within the living space of the vehicle.**

Combustion air intake assemblies and flue gas vents must be installed through the roof of mobile homes so that they can be extended to a minimum of 24 inches to the bottom of the flue gas vent outlet and to at least 20 inches to the combustion air opening, with a minimum of four inches between the openings.

Additional tests include blocked air inlet or vent outlet tests, wind test, rain tests, and vent/intake loading tests.

CSA-B366.1-M1981 Solid-Fuel-Fired Appliances for Residential Use

Scope

Standard B366.1 applies to appliances used in houses but it contains additional requirements for solid-fuel-fired outdoor-aired appliances intended for use in mobile homes.

Outdoor-Aired Units

These units are required to meet the intent of CSA-B140.10 for oil-fired units in mobile homes; they must meet the same installation requirements and be tested to the same firing, wind and rain tests. If these appliances are installed in conventional houses they are required to pass the same tests.

The units are also required to provide automatic control of combustion air drawn from the outdoors. The required components are to be provided and shipped with the appliance. Barometric draft controls are not allowed. An indicator showing the approximate position of the combustion-air damper must be visible.

CSA-B366.2-M1984 (ULC-S627-M1984) Space Heaters for Use with Solid Fuels

Scope

Part A of B366.2 applies to space heaters for use in houses and has already been described. Part B contains additional requirements for units used in mobile homes; mobile home appliances must meet the requirements of both Parts A and B.

Mobile Home Requirements

A combustion air inlet, chimney and a chimney termination must be tested and provided with the heater, and the heater must be designed so that all the combustion air is supplied from outdoors. The 100 percent closure dampers on the air intake called for in house installations are required in mobile homes to be interlocked with the flue damper so that opening the flue damper will also open the air damper. The air damper must have an indicator as part of the space heater to show the damper's position.

Combustion Air Supply

11.4.1 A space heater shall have a combustion-air inlet(s) at least as large in effective area as one-half of the area of the flue. This air inlet shall be designed to prevent material from dropping into the area beneath the mobile home, and to prevent rodents from entering from the outside. The air inlet shall be designed to permit zero clearance to combustible construction.

Performance tests are specified.

ULC-S610-M1979 Standard for Factory-Built Fireplaces

Scope

This standard covers factory-built fireplaces using solid fuels for use in buildings. Part B contains additional requirements specific to outdoor-aired fireplaces for use in mobile homes.

The standard includes requirements for construction, materials and performance testing. Part A contains requirements for outdoor air combustion ducting, but only if the fireplace is fitted with inlets:

5.12.1 Where a fireplace is provided with combustion air inlets, the ducting to the fireplace shall be at

least as large in effective area as one-half of the area of the flue.

5.12.2 Dampers allowing 100% closure shall be provided in the air intake.

Part B, Section 10.4 makes these combustion air inlets mandatory for factory-built fireplaces installed in mobile homes.

Related Documents on Mobile Home Standards

Readers are referred to Mobile Home Appliance Standards and Airtight Homes, a review of standards covering outside-aired, direct-vent, fuel-burning appliances to assess their applicability to airtight homes. Prepared by CSA for EMR's BETT program in May 1983, that report recommended "modifications to existing appliance installation codes or a new installation code for fuel-burning appliances in airtight housing." Photocopies of the Abstract, Executive Summary, and Recommendations are included in Appendix B.

A study that assessed the applicability of the requirements for solid-fuel appliances in mobile homes for use in low energy or airtight housing was conducted by Energy Pathways for the Canadian Standards Association in 1984. The report, entitled Solid Fuel Burning Appliances for Use in Low Energy Housing, March 1984, reviewed the solid-fuel standards and features of mobile home requirements, made several recommendations, and concluded that the requirements for mobile home appliances are not applicable to low energy housing.

It recommended that the standards committees should work more closely and that suitably labelled appliances are available when the market demand for such equipment becomes greater. Photocopies of this report's review of the standards and features of mobile home requirements are included in Appendix B.

4.8 R-2000 Program Requirements

Many organizations are pushing hard for new, improved codes and standards to specifically address the issue of supplying combustion and replacement air in tight houses. The requirements of the R-2000 program are the most specific but it is impossible to say if they are indicative of national building code requirements in the future.

R-2000 houses are required to test at 1.5 air changes per hour or less at a 50 Pascal pressure difference, and they must be able to supply 0.5 air changes per hour or a minimum of 50 L/s (100 cfm) -- whichever is less -- of continuous variable-speed controlled mechanical ventilation for the whole house and distributed to every room.

As well, "consideration must be given to supply replacement air for all appliances exhausting air from the home."

Combustion Air Supply

Naturally aspirating gas-fired equipment is not allowed; only sealed combustion, induced, and forced draft flue systems are permitted.

Oil-fired equipment is only permitted where there is no economic alternative and must be provided with automatic flue dampers. Combustion and dilution air must be supplied at a temperature of at least 10°C unless the manufacturer's specifications permit lower temperatures.

All solid-fuel equipment, including wood stoves and fireplaces, must be equipped with tight-fitting doors, dampers and chimney connections, and they must have a separate outdoor air supply designed to meet the total combustion air requirement.

Furnace rooms are not permitted without "adequate" combustion air supply and without assurance that air temperatures will be high enough to prevent the build-up of ice or moisture in the flue.

Technical Basis for R-2000 Requirements

The R-2000 requirements have undoubtedly resulted in part from discussions with officials in EMR's Combustion Research Laboratory. A spokesman there believes that the banning of naturally aspirating gas furnaces will solve "98 percent of combustion air problems."

The technical basis of the regulations seems self-evident, given that no specific sizes or measurements are given as the requirements use performance-oriented phrases begining with such words as "adequate" and "sufficient."

Recent Changes to R-2000 Requirements

Significant changes to the R-2000 requirements were announced early in 1985, taking effect on March 31 when the existing requirements expired.

The following three changes were made:

1. All exhaust equipment is considered as a group and make-up air has to be supplied for them all.

2. Forced-draft appliances and central heating systems are required wherever possible -- that is, wherever they are available and economic.

3. All combustion appliances, including water heaters, must be "isolated" -- that is, sealed indoors and drawing their entire combustion air through a direct duct to the outdoors. Fireplaces now require sealed doors with the air supply inside the doors. No appliances requiring dilution air are allowed. Flow-proving devices are required with the capability of turning off the appliance if backdrafting occurs.

One combustion engineer expressed the view that the third requirement is a case of overkill, arguing that direct outside air is not necessary if the appliances also contain flow-proving devices with the capability to turn off the equipment.

These requirements are expected to be reviewed and upgraded even further in 1986.

R-2000 officials are concerned over a number of issues relating to combustion air supply in tight houses. They are worried about the following specific issues:

- correctly sizing air supply systems for both combustion requirements and compensation air.
- the pooling of cool air in sealed furnace rooms as opposed to using direct coupled systems.
- the effect on combustion air intakes of wind pressures on the windward and leeward sides of the house; a split intake going to two different sides has been suggested.
- air intakes to fireplaces which react differently if they are on the side or bottom of the box.
- fireplace tight doors that aren't.
- the problem of blowers in sealed furnace rooms creating their own negative pressure zone and cause the vent to spill the combustion gases. The spilled carbon dioxide in turn starves the flame, producing fatal carbon monoxide.

- air intakes that may be located above the house's neutral pressure plane, leading to infiltration down the chimney, particularly as combustion dies down and exhaust gas temperatures lower.

They refer to cases of carbon monoxide poisonings cited in the Hatch report and they have draft-edition reports from their own researchers showing that forced-air systems are the only solution to prevent gas-fired equipment from back-drafting under certain wind conditions.

4.9 Other National Requirements

Northern Standards

A draft document called Northern Residential Standards for Energy Efficient Housing is an energy-related residential building standard intended to be suitable for the North, including the Northwest Territories, the Yukon, and those portions of provinces which experience permafrost. It is expected that the Federal Government will use this standard for all residential buildings falling within its jurisdiction.

This standard is being prepared by an intergovernmental committee under the lead of Energy, Mines and Resources. In 1984 it was released as a draft version. This new standard is based closely on the 1980 Residential Standards, a CMHC document in turn based on the 1980 National Building Code. Most of the changes in the 1985 National Building Code have also been included.

Photocopies of the appropriate sections are included in Appendix B.

Section 34 presents the requirements for the design and installation of heating systems, appliances and equipment, including furnaces, boilers, service water heaters, solid fuel stoves and cooking equipment in which the heat input to the system or appliance does not exceed 120 kW.

Under the general terms of Section 34, appliances must be installed in accordance with the 1985 NBC plus the various CSA and CGA standards -- B139 for oil-fired equipment, B149 for gas equipment, and B365 for solid-fuel fired equipment.

No solid fuel appliances are permitted that can be operated with their doors open. Masonry fireplaces must conform to Section 22, which requires that the provision for outdoor air shall be at least one-half the area of the flue.

Specific requirements are spelled out in Subsection C, Supply of Air to Combustion Appliances:

(1) Except as provided in (2), a combustion appliance that is designed to discharge the products of combustion to the outdoors through a flue shall be supplied with air for the purposes of combustion and dilution from the outdoors to the appliance, in a manner that prevents the interaction of the combustion and dilution air with the air in the room or space.

(2) Where combustion appliances or equipment are located in a combustion equipment room or enclosure, they shall be supplied with air from the outdoors in sufficient quantity for purposes of combustion and dilution. The supply of air shall not result in ambient temperatures within the service room or enclosure of less than 10°C.

(3) Air supplied to combustion appliances using liquid or gaseous fuels shall be at a temperature of not less than 10°C, unless the manufacturer's instructions permit lower temperatures for combustion air.

(4) Dilution air shall be at a temperature of not less than 10°C before it comes in contact with products of combustion.

(5) All ducts and openings supplying air to combustion appliances shall meet the requirements of B(4) and shall conform to the requirements of Subsection 33E.

Subsection 33E presents the requirements for natural and mechanical ventilation systems, and covers such items as screens on intakes, mixing devices for return air connections, duct insulation, and safety from contamination.

According to the Commentary to Northern Residential Standards, a companion volume, the use of combustion equipment with an airtight casing that draws its combustion and dilution air straight from the outdoors is considered to be the solution to the problem of drawing combustion products into the house. Thus, Clause C(1) is considered the way of the future, while Clause C(2) covers the use of conventional equipment although Clause D(1) requires that such non-sealed equipment must be installed in a well-sealed combustion equipment room to prevent drafting.

CGSB

A Canada General Standards Board committee, with funding from EMR's CHIP program, is trying to develop a handbook on retrofit air sealing. The future of this committee is uncertain, as the CHIP program is scheduled to end on March 31, 1986, and so far no other funding sources have been identified. The working group on ventilation standards is expected to produce a draft standard by that time.

In the past, combustion air requirements were "kept in mind" but, according to the secretary, the meeting of Nov. 28, 1984 was the first time that any positive direction was taken relating to these concerns. At that meeting, CMHC's Technical Research Division presented the draft findings of a study on the Thermal and Aerodynamic Performance of Chimney Flues. That study developed a computer model to predict the conditions under which backdrafting can be predicted. The final report was expected in early 1985.

A second presentation at that meeting discussed a ten-step checklist being developed for air-sealing contractors to determine whether backdrafting conditions could occur, even when all exhaust devices are in operation simultaneously. The final version of the checklist was also expected early in 1985.

Efficiency and Emissions of Solid-fuel Appliances

A CSA committee is working on a draft of B415 on the efficiency and emissions of solid-fuel-fired appliances. The committee wants to have the peak flue gas flow rate stamped on the product certification label. Although it was not the intention of the committee, this requirement would be equally useful for determining combustion air requirements.

A combustion engineer on the committee has indicated that this rating of individual fuel-fired appliances should be extended to gas and oil equipment, with certain assumptions allowed for dilution air requirements for natural gas systems.

Energy Evaluation and Labelling of Houses

A draft standard on the energy evaluation and labelling of houses (CSA-F389), now in the fourth draft of its first edition, sets forth procedures for evaluating the seasonal net heat loss and space heating energy requirements. It specifies a method of obtaining information from design drawings and specifications and identifies the energy parameters and assumptions used. It describes minimum inspections and tests required and establishes a labelling procedure based on the calculated energy usage. It applies to new single detached, semi-detached, and row or townhouses.

Kerosene Heaters

Draft standards for portable kerosene heaters (CSA B140.9.3) were issued in May 1984 and are now at the first level of approvals by the committee. However, these standards deal primarily with the units themselves and will not likely contain any reference to air supply.

Installers

Another set of standards (CSA-B601) covers chimney sweeps, installers and inspectors of solid-fuel fired systems, but these are qualification standards and deal only with the personal qualifications of the technicians in these fields.

Chimneys

CSA has also organized a meeting for interested parties to discuss the issues of chimneys, primarily residential. This group will try to pull together existing and on-going research on chimneys which, up till now, has not been coordinated. It will then make recommendations to existing organizations about areas needing additional research.

Code Adoption

The *National Building Code* is a model document and has no authority until it has been adopted by an appropriate jurisdiction. Not all jurisdictions have yet adopted the 1985 edition. Some provinces and localities use earlier versions, and some modify the NBC to suit their own specific applications. Some provinces have no building code at all but require municipalities to adopt their own building code. Both the Yukon and the Northwest Territories automatically adopt the latest version.

New versus Retrofit

Although the *National Building Code* specifically applies to the design, construction and occupancy of new buildings and the alteration and reconstruction of existing buildings, this review was unable to ascertain how extensively retrofit installations of heating equipment are enforced to code requirements, as local jurisdictions may rule that such retrofits are not required to meet the code requirements.

Mobile Homes

Mobile homes are normally certified by the Canadian Standards Association at the factory where they are manufactured. Local building inspectors usually are only involved in the case of factory-manufactured modular homes, which are installed on a foundation, in which case the building code applies.

5.1 Provincial Building Codes

Newfoundland

The province of Newfoundland has not adopted the *National Building Code*. Municipalities are required to adopt their own code, but the policy of the Department of Municipal Affairs is to approve only the NBC. According to the director of Urban and Rural Planning, 244 of the 306 municipalities now have adopted the NBC. These 244 municipalities represent over 92 percent of the population living in incorporated areas.

The provincial Fire Commissioner must approve the construction of all buildings except one and two unit family dwellings.

Prince Edward Island

Charlottetown and Summerside both use the National Building Code, but the rest of the island has no building code at all although the National Electrical Code and the National Plumbing Code are in effect. Outside the two main municipalities no construction permits are called for, only a "development permit" which calls for meeting zoning requirements. The province has its own Fire Prevention Act.

The province's chief property development officer suggests that the most common problem with tight houses is excessive humidity, which the islanders typically solve by installing a basement-to-attic ventilator with a wind-driven turbine on the roof.

Nova Scotia

Nova Scotia has no building code of its own. A bill to adopt the National Building Code was passed in the 1970's but was never given royal assent. That bill increased the energy conservation standards from the 1977 Measures for Energy Conservation, which were felt to not go far enough, but some provincial forces fought against it. The issue still flares up occasionally, including during the autumn of 1984.

Forty-nine of the 66 municipalities have adopted the 1980 edition of the National Building Code, the only code that the province will approve. The provincial Fire Marshall's office examines all building plans, except those for single family and duplex units, for conformance to fire safety regulations.

A spokesman for the Department of Municipal Affairs suspects that there are many wood-fired equipment retrofits done illegally without permits. A number of fatalities have resulted from fires related to wood-burning appliances.

New Brunswick

Since 1980 all municipalities that have building regulations must use the 1980 NBC and areas under provincial jurisdiction also must use the 1980 edition. Of the 120 municipalities, about 95 use the NBC, and the others generally follow its requirements anyway. It was expected that the 1985 NBC would become the code of reference when it became available.

Except for a few propane vehicles, there is little gas in New Brunswick, and response to R-2000 housing has been only "fair." Local building inspectors are supposed to issue permits and inspect retrofits, but "it's hard to control." The issue of combustion air supply appears not to be a concern, although chimney fire hazards of retrofit woodstove installations are regarded as a problem.

Quebec

The Quebec Building Code was modified in April 1984 and is now based on the 1980 NBC. It applies to new construction throughout the province and applies to public buildings, industrial and commercial establishments and apartment houses over two storeys. Other residential occupancies, normally covered by Section 9, are exempted.

Municipalities in Quebec may adopt the National Building Code or their own building code, provided its regulations are not in conflict with or are not less restrictive than the NBC. An official with the Quebec Ministry of Housing and Consumer Protection indicated that of municipalities with a code, 80 percent use the NBC, although some of the smaller municipalities use no code at all.

Ontario

The current Ontario Building Code was adopted in 1983, based on the 1980 NBC. The Ontario Code contains additional parts to cover requirements for the handicapped and for major residential renovations.

The Ontario Building Code is the responsibility of the Buildings Branch of the Ministry of Housing. However, under the Ontario Energy Act, in place since the early 1970's, the Fuels Safety Branch of the Ministry of Consumer and Commercial Relations has responsibility over hydrocarbon fuel installations -- for gas and oil, with solid fuel specifically excluded.

An Ontario government task force is considering this issue of responsibility for solid-fuel installations and was expected to report in early 1985, recommending either that the Building Code cover all retrofit solid fuel installations or that the Fuels Safety Branch assume responsibility.

More detailed discussion of enforcement of the code within Ontario is included later in this report in Section 5.2, Local Requirements in Ontario.

Manitoba

The 1980 Manitoba Building Code is based on the 1980 NBC and specifies the same standards for combustion equipment. A Buildings Standards Board studies codes and amendments and adopts them, possibly with local variations.

The Fire Commissioner's Office in the Department of Labour is responsible for solid-fuel installations. According to a spokesman in the commissioner's office the Manitoba code is currently being amended to mandate B365-1984 as the solid-fuel code and, although not yet legally in force, its requirements are already being enforced by the inspectors.

Gas and oil installations are the responsibility of the Mechanical Engineering Division. B139 for oil and B149 for gas are closely followed. Advisory Gas Notices are produced, which offer explanations and interpretations of code requirements for commercial applications. At the residential level, the code is followed closely.

Under the Buildings and Mobile Homes Act, mobile homes are considered as houses but are required to conform to CSA Z240 series standards.

Saskatchewan

Most of Saskatchewan's population has been covered by the 1980 National Building Code, adopted by the major municipalities. Outlying areas have no code, and some municipalities use older versions of the NBC. In early 1986, the 1985 NBC will be adopted as the basis for the Saskatchewan Building Code and will be enforced province-wide.

The Technical Safety Services Division is responsible for gas installations as well as the building code. Combustion air supply is not required in single-family units as natural infiltration is considered sufficient. A separate combustion air supply is only required for installations with the furnace in a separate room or where the building is so tightly sealed that infiltration does not meet air supply needs.

One problem is considered to be fireplaces backdrafting gas furnaces, but no fresh air is required for fireplaces, and although "quite a few" fireplaces are installed without permit or inspection, no fatalities have been reported due to backdrafting.

There have been some reported cases of owners blocking air supply ducts to prevent cooling of basements. Laundromats have been found to have plugged air supply openings, resulting in insufficient air for combustion. The B149 installation codes are the standards used for the installation of gas and propane appliances.

Alberta

The 1981 Alberta Building Code, in use for the first half of 1985, was based the 1980 National Building Code with some additional requirements. The 1985 Alberta Building Code, based on the 1985 NBC and including the same additional requirements as the earlier version, went into effect in July 1985.

The provincial building code is enforced by the Department of Labour's Building Standards Branch. There is no provincial requirement for permits, although 95 percent of the population is covered by municipalities which do require permits for solid-fuel installations. The province's few oil-fired installations by default come under the jurisdiction of the Fire Protection Branch, but this was expected to cease with adoption of the 1985 Code.

Alberta is almost exclusively natural gas heated and these installations come under the jurisdiction of the Plumbing and Gas Safety Services Branch, also part of the Department of Labour. The Gas Protection Act requires combustion air for gas furnaces, recommending either direct ducts or a duct open to the basement.

Alberta was the only province before the 1985 National Building Code to have fresh air requirements for residential occupancies. The Alberta requirements may be met in buildings with forced air furnaces by having an outdoor duct connecting to the return air duct of the furnace. Duct and damper sizes are specified in the Alberta Building Code, as shown in the photocopy in the Appendix. These fresh air ducts do not meet the combustion air requirement.

In May 1984 the Department of Labour issued a bulletin to clarify the requirements for combustion air for gas-fired appliances in dwelling units, giving two methods acceptable to both the Buildings Branch and the Gas Branch. A photocopy of the bulletin is contained in Appendix B.

With the first method, a combined combustion air and fresh air duct is connected to the return air duct of the furnace. This insulated duct is sized to meet the quantity of air required for combustion and for all other air requirements. Duct sizes are suggested, based on combined furnace and hot water heater capacity and assuming no more than two elbows. A warm air supply outlet supplying the space in which the furnace is located must be provided either with a fixed damper set at the required air volume for the appliances or with a 100 mm diameter duct with no damper. With this method, the furnace fan should be run continuously.

The second method calls for a combustion air supply duct not coupled to the furnace in addition to the fresh air duct connected to the return air plenum. In this case the combustion air duct must have a cross-sectional area of at least 450 mm^2/kW input rating of all appliances served. This duct must dump into a "cylindrical combustion air container," a bottomless, shrouded container set on the floor in the furnace space. Detailed measurements and proportions for the container are specified.

The Alberta Building Code specifies that for fireplaces, combustion air "shall be provided by an air intake other than a door or window." This requirement does not apply to wood stoves, which have only become popular within the last few years. Inspectors look for a source for fireplace combustion air within the room. Since the gas furnace installation requires an outdoor air supply, a duct connecting the room with the fireplace to the basement is recommended. Direct ducts from the fireplace to the outdoors are also accepted.

The earlier 1978 version of the Alberta Building Code contained a specific duct sizing requirement for solid-fuel equipment based on heat capacity, but that regulation was dropped from the 1981 code due to difficulties in determining the actual heat input which depends on the grade of coal or species and quality of wood being fired. Instead the Alberta Building Code simply specifies that the air supply be "adequate."

This regulation is internally interpreted to mean that a solid-fuel appliance must have a combustion air supply duct equal to or bigger than the flue collar. (This specification of equal to or bigger than the flue is at least twice the size of one-half the flue collar specified by B365-1984.) With this interpretation, wood stoves are required to meet the same combustion air supply requirements as wood stoves, preferably with a duct run to the vicinity of the combustion chamber.

In single-family residences, this requirement is not enforced with so-called "airtight" wood stoves, referred to as "slow burning appliances" in Alberta. These units are deemed to have a need for less air and the combustion air supply to the gas furnace is considered adequate for the needs of "slow burning appliances."

The problem of combustion air supply in tight houses is minor, thanks to a public education program with seminars and pamphlets explaining the requirements for fresh air. Over the last nine years, only two cases have been reported of people being hospitalized due to backdrafting.

British Columbia

The 1980 National Building Code has been adopted by British Columbia, including revisions up to Jan 1984. The 1985 National Building Code is expected to be adopted in early 1986.

In B.C., solid fuel requirements are only enforced in mobile homes, not in normal houses where there is no requirement for outside air supply. It is expected that requirements in the 1985 Code will be enforced, including those for fireplaces. For the last two-to-three years, solid fuel requirements have been more vigorously enforced and the standard of inspections "has gone up 100 percent" although there still are installations without permits.

When the 1985 Code is adopted, the province is expected to make a blanket requirement for a minimum size air intake for stoves and fireplaces, with a variable manual damper so that owners can close the duct when the appliance is not in use.

Permits are required for "anything that affects safety or health," and the province has ruled that this covers fireplaces and stoves; therefore all solid-fuel installations, new and retrofit, require permits and inspections. Insurance companies require a permit for solid-fuel installations.

In B.C., the Ministry of Municipal Affairs enforces the building code, including oil equipment. Gas installations are handled by Ministry of Labour, which requires ducted outdoor air supply in all installations, with no distinction for those buildings with sufficient natural infiltration. Permits are required for all gas installations.

Northwest Territories

The government of the Northwest Territories uses the National Building Code, and the latest edition is adopted automatically. This same automatic adoption process applies to the National Fire Code and all CSA, CGA and ULC standards. The building code applies throughout territorial jurisdictions and municipalities.

No permits are required, but all combustion appliance installations must be inspected by the Fire Marshall. Insurance companies require a letter of approval from the Fire Marshall's office for solid fuel installations. The use of natural gas is recent, and restricted to three communities.

The problem in the north is that if combustion air ducts connected to the outdoors simply discharge into the furnace room, the furnace will not turn off in cold weather as outdoor temperatures are so low. The Fire Marshall prefers to draw combustion from a crawl space or other tempered space and he anticipates problems with R2000 houses ducting direct from the outdoors unless some preheating strategy is used.

The Fire Marshall believes that he is "lucky to get 60 percent of all installations inspected," although the code is followed closely in those cases. He cited as an example the case of a chapel with a propane heater installed without inspection; the Fire Marshall was called in when back-drafting problems occurred; the solution was to undercut the door leading to an unheated porch.

Yukon

The Yukon uses the National Building Code, with automatic adoption of revised codes. Virtually the entire territory is covered, including Indian land as band land is not classed as reserves, so the Building Inspector has jurisdiction. The Building Inspector works under the Fire Marshall.

At least five years ago the Fire Marshall was able to have an order-in-council passed requiring combustion equipment to have an air supply duct one-half the diameter of the chimney. That ratio was determined by the Fire Marshall as being a generally accepted figure after discussions with his staff, with local installers and with CSA officials.

It has been an internal requirement of the fire marshall's office, and a practice followed by local installers, to install forced-air furnaces with a combustion air duct one-half the size of the flue and connect it to the return air duct. Stoves and fireplaces are required to have a similar duct discharging in the vicinity of the combustion chamber. On stoves this duct is permitted to have a damper.

A request for an order-in-council to adopt B365-1984 was expected to die on the order table as the 1985 NBC was automatically adopted as soon as it was released.

Thanks to a strong public education program, people seek advice before installation (and even before buying) and usually request a safety inspection. Insurance companies require a report from the Building Inspector for all combustion equipment retrofits. Installers are aware of code requirements and ask advice from the Building Inspector for problem installations.

Permits and inspections are required for all retrofit combustion equipment. New construction requires a building permit. For new construction and major retrofits, the Building Inspector recommends and requires outside combustion air supply, but for older houses he will accept infiltration with proof that sufficient air is being supplied.

Outdoor air supply is recommended in all instances even if natural infiltration is high enough, in case the owner later seals the house. This is official policy. Installers used to use 6-inch diameter ducts, but have reduced the size. The Inspector now allows four-inch ducts but not three-inch ducts.

Trade practice is to install an outdoor air supply. If plumbing is in the same space, ducts come in at ceiling level and drop to six to eight inches from the floor. This exposed duct allows for preheating of air. Owners often plug ducts in open basements and allow for infiltration to supply combustion air. Usually, however, basements are finished and then the combustion air ducts are needed. Some complaints have been reported of combustion fumes in furnace rooms with washers and dryers, caused by the dryers exhausting the air.

5.2 Local Requirements in Ontario

Although requirements below the provincial level fall outside the scope of this review, information has been gathered on some local requirements in Ontario. The province uses the Ontario Building Code, based on the 1980 NBC, but enforcement of the requirements is spread over several jurisdictions.

The Ontario Building Code is the responsibility of the Buildings Branch of the Ministry of Housing. However, under the Ontario Energy Act, in place since early 1970's, the Fuels Safety Branch of the Ministry of Consumer and Commercial Relations has responsibility for hydrocarbon fuels -- for gas and oil, with solid fuel specifically excluded.

Gas Installations

Gas installations must follow the Ontario Gas Utilization Code, virtually identical to B149, although Clause 6.4.4 forbids automatic dampers on combustion air ducts in single or double family occupancies, which are permitted by B149. The Ontario code does allow automatic dampers with an interlock in commercial installations.

TABLE 3 COMBUSTION AIR REQUIREMENTS FOR HOUSES BY PROVINCE

Jurisdiction and Agency	Current Version	Oil-Fired	Gas-Fired	Solid-Fuel Fired	Fireplaces
National Building Code	1980	B139-1976	B149-1980	3.3 mm^2/W	None
National Building Code	1985	B139-1976	B149-1980	B365-1984*	*
Newfoundland Dept. of Municipal Affairs and Housing	None**				
Nova Scotia Dept. of Municipal Affairs	None**				
Prince Edward Island Dept. of Municipal Affairs	None**				
New Brunswick Dept. of Supply and Services	None**				
Quebec Ministère de l'Habitation et de la Protection du Consommateur	1984 Quebec Building Code***	Houses exempted	Houses exempted	Houses exempted	
Ontario Ministry of Municipal Affairs and Housing	1983 Ontario Building Code***			B365-1982	None
Ministry of Consumer and Commercial Relations		B139-1976	B149-1980		
Manitoba Dept. of Labour and Employment Services	1980 Manitoba Building Code***				
Office of Fire Commissioner				B365-1984	
Mechanical Engineering Division		B139-1976	B149-1980		
Saskatchewan Dept. of Labour	None****	B139-1976	B149-1980		

TABLE 3 (continued) COMBUSTION AIR REQUIREMENTS FOR HOUSES BY PROVINCE

Jurisdiction and Agency	Current Version	Oil-Fired	Gas-Fired	Solid-Fuel	Fireplaces
Alberta Alberta Labour Building Standards Branch	1985 Alberta Building Code*****			B365-1984* "Adequate"	* Combustion air required
Fire Protection Branch		B139-1976			
Gas Protection Branch			B149-1980 Duct required		
British Columbia Ministry of Municipal Affairs	1984 B.C. Building Code***	B139-1976		None	
Ministry of Labour			B149-1980		
Yukon Gov't of Yukon Protective Services Branch	1985 NBC	One-half flue size	One-half flue size	One-half flue size	One-half flue size
North West Territories Justice and Public Services Fire Safety Division	1985 NBC	B139-1976	B149-1980	B365-1984	

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* Applies to central heating systems only. Stoves, ranges, space heaters and fireplaces must be installed in a manner to ensure "complete venting of the products of combustion to the outside air," a process which needs sufficient air for combustion. In addition, compensation for air drawn by other appliances and exhaust equipment is also required.

** Municipalities are required to adopt a building code, but the province only accepts the National Building Code. Some municipalities use the 1980 edition and will likely adopt the 1985 edition.

*** Based on the 1980 edition of the National Building Code

**** Most municipalities have adopted the 1980 National Building Code, although some use an earlier version. The 1985 National Building Code is expected to be adopted as the Saskatchewan Building Code in early 1986.

***** Based on 1985 edition of the National Building Code.

A spokesman for the Fuels Safety Branch expects that this restriction will be revoked, as the automatic dampers are better than simply leaving an open duct which consumers may block. During the interviews, several industry representatives indicated that automatic dampers were being installed in residential occupancies.

The spokesman also indicated that there is a trend to eliminate natural aspirating equipment, and he expects that induced fans will eventually be required. Passive ducts, he pointed out, are simply too dependent on exterior winds and so on. He indicated that manufacturers may come up with retrofit inducing fans for existing equipment.

The Fuels Safety Branch licenses all oil and gas installers in the province. The Branch has 35 field inspectors. Gas inspections are done by the local gas utility whenever new gas piping is installed.

Oil Installations

Oil installations follow B139-1976 and are the responsibility of the installer or owner, with inspection by the municipality if there is a bylaw requiring permits and inspections. According to a spokesman for the Fuels Safety Branch, most municipalities don't have such a bylaw, only the major ones.

Solid Fuel Installations

Solid fuel installations are enforced only at the municipal level, which includes most of the province except for unorganized territories with no elected council.

Unofficial estimates suggest that 50 percent of solid fuel installations are done by owners without permits, about 10-15 percent by owners with permits, and the rest by professional installers with or without permits, depending on local bylaws.

A number of problems with solid fuel installations occur. Problems may occur between inspectors and installers if inspectors follow the Ontario Building Code, which calls up the 1982 version of B365, and installers follow the later 1984 version, as recommended by the Canadian Wood Energy Institute. For example, the 1982 version calls for a combustion air duct 1.5 times the diameter of the flue whereas the 1984 version only requires it to be 0.5 times.

The Ontario code requires that installations comply with manufacturers' instructions and B365-1982. A spokesman for the Buildings Branch explained that, in case of a conflict, the manufacturers' instructions are considered to take precedence.

A report entitled Residential Wood Heating: Research Project on Technical Training, Inspections and Regulation in Ontario was prepared for the Ontario Ministry of Energy by the Canadian Wood Energy Institute in March 1984. This report highlights a number of the problems mentioned here. A photocopy of the report's Executive Summary is included in the Appendix.

Other problems occur with the installation of combination units where half the unit is covered by the Ontario Building Code and the other half by the Fuels Safety Branch (or Ontario Hydro for electric combinations).

Although the Ontario Building Code specifically covers new construction and "material alterations," the Ministry of Housing has not yet given its interpretation as to whether the installation of wood stoves constitutes a "material alteration."

Thus, the municipalities have to make the decision, and the results vary. In London, for example, a permit is not required if a wood stove is connected to an existing chimney, but a permit is required if both stove and chimney are new. In Ottawa, any new wood stove or fireplace insert requires a permit and inspection, but the responsibility for obtaining the permit is the owner's, not the installer's.

If the Ontario Building Code is considered locally to cover only new construction, then the provincial Fire Code comes into effect. The Fire Code references

B365 and requires conformance with manufacturers' instructions

5.3 Professional Association Requirements

ASHRAE Fundamentals

The *National Building Code* has a general requirement that the design, construction and installation of central heating systems shall conform to "good engineering practice" and cites as examples, among others, ASHRAE procedures.

ASHRAE Handbook 1981 Fundamentals covers Combustion and Fuels in Chapter 15. A description of the chemical process of combustion is given and fuels are discussed by type -- gaseous, liquid and solid.

Combustion calculation procedures using molecular mass (weight) are explained, but everything is explained in theoretical terms. There is no discussion of how the calculated air requirements are to be supplied to the appliance.

Chapter 22 of *Fundamentals* discusses Ventilation and Infiltration which only deals with the control of indoor contaminants, refers to studies in the 1920's dealing with the dilution of body odours, and admits that ventilation requirements have evolved on a consensus basis. There is no reference to combustion air requirements.

ASHRAE Draft Standard

ASHRAE also has a standard on Energy Conservation in New Building Design, published in 1980. HVAC equipment covered includes residential oil- and gas-fired furnaces and boilers, all vented home-heating equipment, and to commercial units with inputs of less than 117 kW (400,000 Btu/h). The pertinent section is:

6.6.3 Adequate Combustion Air

a. Residential and Commercial Installations. For residential and commercial installations with inputs under 117 kW (400,000 Btu/h), it is the system designer's responsibility either to establish that the total minimum calculated infiltration rate will provide sufficient combustion air for fuel--fired equipment, or to provide positive means for introducing adequate outdoor air for that purpose.

The proposed ASHRAE standard then cites as references the U.S. installation codes for oil and gas appliances.

In an attempt to get a feeling for how the provisions of the various combustion air supply codes are regarded in the field, interviews were conducted with inspectors, utilities, trade associations, manufacturers, technical institutes, low-energy builders, and installers.

The following information on interpretation and possible compliance was based on these personal conversations and therefore constitutes individual opinion and does not represent any official policies. That warning aside, it probably does portray -- together with the preceding chapter on the provincial and local situation -- a reasonable picture of what is happening in the residential fuel-fired heating industry.

6.1 Inspectors

In Ottawa, new construction requires a building permit which includes both the building and the heating system. Most new construction is gas heated and installers are making provision for combustion air into the basement or furnace room. The suspicion is that most home-owners block the ducts to keep out the cold drafts.

For retrofits, the city issues a separate HVAC Replacement Permit and inspects the finished job, although most gas conversions are done without a city permit and the Buildings Branch does not have enough manpower to enforce the requirement, relying instead on the utility inspection before the gas supply is turned on.

Officially the Fuels Safety Branch of the Ontario Ministry of Consumer and Commercial Relations is responsible for the installation of the furnace itself, but they leave it to the local utility, Ottawa Gas.

A spokesman for the utility says that inspectors follow the minimum requirements for B149 as closely as possible, but point out that it is difficult in retrofit installations to determine if there is adequate infiltration. They find that most houses, including new ones, are not as tight as people think. Generally they rely on a visual check for fireplaces and exhaust fans and will ask the installer for an outdoor duct if these are present, but no test is conducted. Probably most retrofits do not supply outside air ducts.

A spokesman for the city's Buildings Branch suggested that oil furnace installations "rarely" supply combustion air ducts, even in new construction, because the blower on the oil burner appears to supply sufficient air.

The only complaints prompted by insufficient air have occurred with fireplaces smoking. Some 60%-70% of new single family residential units (detached, semi-detached, row houses and townhouses) are being constructed with factory-built fireplaces and an outside supply of combustion air is considered essential. Those units that come with glass doors with factory-supplied integral air ducting work well.

Wood stoves are mostly retrofit installations and city officials estimate that 70%-80% are done with permits, although combustion air supply is not regarded as a problem with stoves.

6.2 Trade Associations

Canadian Gas Association

The Canadian Gas Association, the organization which produces the standard for gas installations, also produces a Gas Appliance Installation Manual for use by installers. A photocopy of the appropriate pages of the current edition is included in Appendix B.

The manual contains a section on the natural gas combustion process and briefly outlines the chemistry involved. It discusses the hazards of incomplete combustion, explains the dangers of carbon monoxide, and covers combustion efficiency versus carbon dioxide. It emphasizes that excess air must be kept to a minimum to reduce make-up heating losses, and points out that with conversion burners the installer must set the combustion air supply to suit the rate of gas flow -- a process described in detail in another section.

The Manual's section on ventilation and combustion air supply reiterates the warning that "consideration must be given" to the supply of combustion air, but adds

> **Unfortunately there is no simple method available to indicate the adequacy of this air supply. Atmospheric conditions can change from day to day and even hour by hour, altering the effectiveness of the air supply in any area and only experience can dictate when all of the factors have been considered for each specific installation and assurance of sufficient air supply under all operating conditions has been obtained.**

The Manual explains the requirements of B149 and uses simple diagrams to show the opening locations and ducting configurations. No reference is made to replacement air.

Heating, Refrigeration and Air-Conditioning Institute

A spokesman for the Heating, Refrigeration,and Air-Conditioning Institute (HRAI) suggested that most gas installations follow the code requirements closely because they are inspected by the utility, but that oil installation requirements are not enforced as well. The individual installer has to make a judgment as to whether the extra cost and work involved to install combustion air suppy ducts is justified.

The R2000 program's banning of naturally aspirating furnaces in low-energy houses is regarded as making sense. Most low-energy houses are custom-built and many use electric heat as the simplest solution to the problem, probably because of the higher cost of induced draft and direct-supply appliances. Installers are aware that the R2000 program requires a controlled combustion air supply.

Interlocked motorized dampers on combustion air supply ducts, in the $100-150 price range, are a possible solution to the problem of cold basements and furnace rooms while meeting the requirements for outside air ducts. (This statements appears to confirm the opinion given by a Fuels Safety Branch official with Ontario's Ministry of Consumer and Commercial Relation who said that even though such devices are specifically banned in single and double family residential occupancies they are still being installed.)

Product literature for a Canadian-made CGA-approved motorized damper is included in Appendix B.

Mechanical Contractors Association

Members of the Mechanical Contractors Association do virtually no work in the residential field and there is no comparable organization dealing with mechanical systems in housing.

Canadian Wood Energy Institute

The Canadian Wood Energy Institute is concerned that more often than not retrofit space heaters are installed without permit or inspection and that even if a permit is obtained the code requirements are not strictly enforced.

Fireplaces in tight houses are a concern because satisfactory air supply is only possible for factory-built units with air-tight doors. Fresh air kits are only available for a few makes of wood stoves because they can only be connected to units that have an appropriate collar for attaching the duct-work.

6.3 Low-Energy Builders

Builders in Ontario with experience in the solar and low-energy building area tend to rely on forced-air electric furnaces to avoid any problems with combustion air supply. One low-energy builder normally specifies condensing furnaces, but other builders feel that these units are too expensive and cannot be economically justified in tight houses when compared to around $500 for an electric furnace.

Most low-energy houses include wood stoves rather than fireplaces and use the manufacturer's optional "fresh air packages," typically less than $100 for duct and exterior intake hood. One problem with this solution is that the manufacturers change their products frequently, which makes specification-writing difficult.

6.4 Appliance Manufacturers

Furnace manufacturers appear to have no problem accepting the National Building Code requirements but they are uncertain as to where the code is going since the exact figure for ventilation requirements is still uncertain.

Manufacturers are aware that the combustion air requirements for standard gas furnaces cause problems in tight houses with fireplaces, and readily suggest that airtight houses require either high-efficiency or induced-draft appliances. No problems have been reported with these appliances in the field. Originally the code required metal vents for high-efficiency gas furnaces but the industry feels that the committees "came around" to seeing their view.

A manufacturer of all types of furnaces -- oil, gas and electric -- said there was "no proper answer" for heating in tight houses except forced air electric furnaces and electric water heaters, although he felt that the pick-up time for electric water heating is too slow and prefers gas. He suggested that going all-heating in tight houses except forced air electric furnaces and electric water heaters, although he felt that the pick-up time for electric water heating is too slow and prefers gas. He suggested that going all-electric in tight houses was less expensive, both for the appliances and because it eliminating the combustion air supply ducting.

Another spokesman suggested that days of naturally aspirating gas furnaces may be over and that retrofit induced draft blowers will likely become available for existing equipment.

An equipment manufacturer pointed out that domestic hot water heating costs have greatly increased over the last ten years, particularly in relation to space heating costs in low-energy houses. He foresees the introduction of combined space and domestic hot water heating appliances using a single fuel, either gas or electricity, as a strong market for these products develops over the next few years in low-energy homes. Such appliances, he indicated, could also make use of a heat pump.

6.5 Installers

In Ontario, installers of oil and gas equipment have to be licensed by the Fuels Safety Branch of the provincial Ministry of Consumer and Commercial Relations. No such licensing applies to installers of solid-fuel equipment.

In the wood-burning community, Installation Code B365-1984 is regarded as a quality document and many installers appear to follow its requirements voluntarily. In Ontario, however, there is concern about conflict between building codes and installation standards and the resulting confusion in the minds of installers and inspectors.

According to the Canadian Wood Energy Institute, installers are trained to follow the latest Installa-

Installation Code. Inspectors may find the building code confusing in such areas as having to apply both Parts 6 and 9.

According to a recent study by the Canadian Wood Energy Institute, only 37% of the building inspectors surveyed had any training whatsoever. Many in non-urban areas are only part-time employees and are uncertain of their legal liability if they don't follow the code to the letter.

One installer interviewed during the study said he would not install a wood stove without an outside air duct if he thought the house was as tight as an R2000 house. He offered the opinion that it is impossible ("unless the owner is a fanatic") to tighten an existing house enough to cause problems with the new generation of wood stoves. He also reported cases where the local gas utility, having inspected a house where a wood stove or fireplace had been added and the owner had complained of fumes from the furnace, had threatened to shut off the gas in 12 days if an outside combustion air duct were not added.

Installers appear to feel that the easiest way to supply combustion air is to run an air supply duct to the return air supply of the furnace. There is a rumour, however, that if the connection is too close to the furnace the sudden introduction of cold air may cause condensation and thus possibly shorten the life expectancy of the heat exchanger, but none of the installers knew of an actual case where this had happened. The recently approved automatic, interlocked dampers for passive combustion air ducts appear to be highly regarded.

Code Requirements

The regulations for the installation of fuel-burning appliances in houses are found in the National Building Code and various provincial legislation. The current edition of the NBC is 1985, still in the process of being adopted by provincial jurisdictions across the country.

The regulations for the installation of combustion equipment in mobile homes are found in the Z240 series of standards produced by the Canadian Standards Association, plus additional fuel-specific appliance standards. The appliance standards usually come in two parts, the first applying to equipment for use in houses and the second applying to equipment for use in mobile homes.

National Building Code Requirements

The National Building Code generally specifies that combustion heating equipment be installed according to good engineering practice, a requirement that would allow combustion air needs to be calculated on a theoretical basis which, together with certain assumptions on flow rates, would allow opening sizes to be calculated. It is probable that the rules of thumb used to determine the code requirements were originally calculated in this way.

Under the 1985 edition of the National Building Code, all solid-fuel fired stoves and space heaters must be installed to ensure complete venting of the products of combustion and compensation must be made for air drawn by other appliances and exhaust equipment. No specific measures are spelled out explaining how to meet these requirements and no tests are available to prove that they are being met.

The National Building Code references fuel-specific codes for gas-fired, oil-fired, and solid-fuel-fired appliances. These codes are generally enforced at the local level in the case of oil and solid-fuel appliances and at the provincial or utility level for gas equipment.

Gas Installations - B149

Canadian Gas Association standard B149-1980 must be followed for the installation of all gas-burning equipment. B149 comes in two parts; part 1 applies to natural-gas-burning equipment and part 2 applies to propane-burning equipment. Except for details regarding the storage and piping of propane, the two parts are identical and are simply referred to as B149 by most users and in this report.

Revisions to B149 were ratified in late 1985 and the revised code is expected to be released in early 1986. Included in the changes are reduced opening sizes for combustion air ducts plus a requirement that they terminate at a specified distance close to the burner. Sizing tables will be provided to indicate the necessary air supply requirements.

The biggest change to B149 is a requirement that an outdoor air supply must be provided if the house is of "tight construction" or if it has a Equivalent Leakage Area of 78 square inches (0.05 m^2) or less, as determined by a fan depressurization test at a 10 Pa pressure difference. "Tight construction" is defined as a building with close-fitting doors and windows, a continuous sealed vapour barrier, and drywall or plywood with sealed joints.

Oil Installations - B139

Canadian Standards Association standard B139 is required for oil-fired appliances. It too requires certain outdoor-connected ductwork if the house is deemed to have tight construction, but no definitions or tests are suggested.

Solid-Fuel Installations B365

CSA standard B365 is required for solid-fuel-fired equipment. This code was completely revised in 1984 and requires an outdoor air supply if natural infiltration is insufficient. Trial and error is suggested as the method for determining the appropriate opening size, and 0.5 times the flue collar area is suggested as a guide. Boilers and furnaces, plus other appliances in tight houses must have a permanent opening to the outdoors of at least 3.3 mm^2/W (1.5 $in^2/1000$ Btuh) input. A minimum duct diameter of 4 inches and a maximum length of 3 metres with no more than two 90° elbows are specified.

Mobile Home Requirements

Mobile homes -- transportable single family dwellings complete structurally with plumbing, electrical and heating systems installed at the factory -- fall outside the scope of the National Building Code. Instead, they are inspected and certified at the factory by the Canadian Standards Association to the CSA Z240 series of standards.

These Z240 mobile home standards require complete separation of the combustion system, including combustion air supply, from the atmosphere of the living space. For other than sealed-combustion units, outdoor opening sizes are specified according to heat capacity input. For sealed-combustion units the standards require the manufacturer to determine the correct size and to provide and ship the ducts with the appliances.

CSA Z240.4.1-M1983, Installation Requirements for Gas Burning Appliances in Mobile Homes, is the only code reviewed that contained a specific requirement for replacement air. For gas-fired clothes dryers, a duct is required near the dryer with an area not less than twice the dryer exhaust.

Several appliance-specific standards apply to both houses and mobile homes. These include direct-vent-type gas furnaces, outdoor-aired solid-fuel appliances and factory-built fireplaces. For gas and outdoor-aired solid-fuel central systems, the combustion air duct is sized by the manufacturer and supplied with the system. For solid-fuel-fired space heaters and factory-built fireplaces, the outside air duct is to be one-half the flue collar area.

Technical Basis for Code Requirements

All the applicable codes and standards are written by committees representing code authorities, the industry and sometimes users. These committees operate on the concensus principle.

The requirements are based on long-standing rules of thumb worked out for an older generation of housing construction standards with higher natural infiltration rates. The problem of supplying combustion air in so-called tight housing is solved with a catch-all requirement for "sufficient" or "adequate" air for combustion plus compensation for replacement air. These terms are generally not defined.

The air supply duct sizes are technically sound but appear to be somewhat oversized (as far as combustion air alone is concerned) and err on the side of safety. This study was unable to find any specific tests or other research behind the code requirements and none of the code authorities contacted was aware of any such work having been done, although they all agreed that the numbers specified were reasonable and had stood the test of time.

The one-half-the-flue-collar ratio for solid-fuel-fired appliances appears to be a rule-of-thumb worked out during manufacturers' testing and assures that the units will not experience any smoking problems.

Possible Modifications

The 1985 edition of the National Building Code was released in April 1985. It specifies the most recent edition of all the fuel-specific installation codes which, in turn, typically reference the most recent appliance certification standards.

The solid-fuel appliance code B365 was reissued in 1984. The oil-fired appliance code was last issued in 1982 and the committee remains inactive. B149, the gas-appliance installation code, is scheduled to be reissued in a revised form in early 1986. It is the first installation code to address the issue of determining whether natural infiltration is sufficient to supply combustion air.

The most specific requirements currently in force are those of the R2000 Housing Program. Naturally aspirating equipment is forbidden. Only sealed or forced-draft furnaces are allowed and all solid-fuel equipment including stoves and fireplaces must have an independent outdoor air supply. New regulations went into effect in 1985 which require that all combustion devices must be isolated and that make-up air must be supplied for all exhaust equipment.

Application and Compliance

The National Building Code, through provincial or local adoption, is in force in most of Canada although different jurisdictions use different editions. It is expected, however, that the new 1985 edition with its updated requirements will be in effect in most of the country in 1986. In the Yukon and the Northwest Territories it went into effect automatically as soon as it was released.

Generally speaking, the requirements of building codes are enforced at the local level. Although permits and inspections are now required in most urban areas, a number of smaller municipalities and most rural areas still have no code enforcement whatsoever.

It appears that most natural gas installations follow the code requirements closely in supplying outdoor air in new construction even though the responsibility for determining the house's tightness rests with the installer. Gas installations are inspected either by by the utility or by the province.

Alberta requires outdoor combustion air ducts for all gas furnaces and the Northwest Territories requires combustion air ducts for all combustion appliances in new construction.

Across the country, oil and solid-fuel installations are probably not as rigidly adhered to, especially in the case of retrofit stove installations. The only significant problem area appears to be fireplace installations, particularly in new construction, and gas-furnace installations in houses with open fireplaces.

In the case of mobile homes, the individual manufacturers voluntarily apply to have their products certified by the Canadian Standards Association to all the relevant standards. Virtually all mobile homes in Canada appear to be subjected to this certification procedure.

Most people contacted during this study expressed awareness of the problem and varying degrees of concern, but the concensus was that the problem is not a severe one. Smaller builders specializing in low-energy building typically avoid the problem by using forced-air electric furnaces.

APPENDICES

A BIBLIOGRAPHY

Photocopies of Codes and Standards

B BIBLIOGRAPHY

Photocopies of Related Documents

C ORGANIZATIONS CONTACTED

D INTERVIEW DOCUMENTATION

BIBLIOGRAPHY: Photocopies of Codes and Standards

1980 National Building Code A3

1985 National Building Code A15

CSA-B139-1976 Installation Code for Oil-Burning Equipment A23

CAN1-B149.1-1980 Installation Code for Natural Gas-Burning Appliances and Equipment A35

CSA-B365-1984 Installation Code for Solid Fuel Burning Appliances and Equipment A41

CSA-B366.1-M1981 Solid-Fuel-Fired Appliances for Residential Use A45

CSA-B366.2-M1984 Space Heaters for Use with Solid Fuels A51

ULC-S610-M1983 Standard for Factory-Built Fireplaces A57

CSA-Z240.5-1971 Oil Requirements for Mobile Housing and Recreational Vehicles A61

CSA-B140.10-1974 Oil-Fired Warm Air Heating Appliances for Mobile Housing and Recreational Vehicles A65

CSA-Z240.4.1-M1983 Installation Requirements for Gas Burning Appliances in Mobile Homes A73

CAN1-2.19-M81 Gas-Fired Gravity and Fan Type Direct Vent Wall Furnaces A77

CAN1-2.3-M84 Gas-Fired and Forced Air Central Furnaces A85

These standards are copyrighted by the Canadian Gas Association and the Canadian Standards Association and are reproduced here with their permission. Because standards are constantly being revised, you should contact CGA and CSA to obtain up-to-date information or the latest catalogue. Gas standards may be purchased from CGA, 55 Scarsdale Road, Don Mills, Ontario M3B 2R3 (416) 447-6465. CSA standards may be purchased from CSA, 178 Rexdale Blvd., Rexdale, Ontario M9W 1R3 (416) 747-4363.

1980 National Building Code

PART 6 HEATING, VENTILATING AND AIR-CONDITIONING

SECTION 6.1 GENERAL

SUBSECTION 6.1.1. SCOPE

6.1.1.1.(1) The scope of this Part shall be as described in Subsection 2.1.2.

Repairs or adjustments

(2) Repairs, adjustments or component replacements that change the capacity or extent of safety of an existing heating, ventilating or air-conditioning system and that alter the method of operation shall conform to this Code.

SUBSECTION 6.1.2. APPLICATION

6.1.2.1. This Part applies to systems and equipment for heating, ventilating and air-conditioning services.

6.1.2.2.(1) *Service water heaters* shall conform to the appropriate requirements in this Part and in Part 7.

(2) Pressure vessels shall conform to CSA B51-1975, "Code for the Construction and Inspection of Boilers and Pressure Vessels."

SUBSECTION 6.1.3. DEFINITIONS

6.1.3.1. Words that appear in italics are defined in Part 1.

SUBSECTION 6.1.4. MINIMUM METAL THICKNESS

6.1.4.1. Where reference documents in this Part specify metal thickness by gauge, the equivalent thickness in millimetres, including allowance for negative tolerance, shall conform to Table 6.1.4.A.

SUBSECTION 6.1.5. PLANS AND SPECIFICATIONS

6.1.5.1. Plans, specifications and other information for heating, ventilating and air-conditioning systems shall conform to Subsection 2.4.5.

SECTION 6.2 DESIGN AND INSTALLATION

SUBSECTION 6.2.1. GENERAL

Good engineering practice

6.2.1.1. Heating, ventilating and air-conditioning systems shall be designed, constructed and installed to conform to good engineering practice such as described in the ASHRAE Guide and Data Books, the ASHRAE Handbooks, the HRA Digest and the Hydronics Institute Manuals.

6.2.1.2.(1) Heating and air-conditioning equipment other than solid-fuel-fired equipment shall be installed in conformance with the requirements of appropriate provincial legislation or, in the absence of such legislation, to the requirements of

- (a) CSA B139-1976, "Installation Code for Oil Burning Equipment,"
- (b) CAN1-B149.1-78, "Installation Code for Natural Gas Burning Appliances and Equipment,"
- (c) CAN1-B149.2-78, "Installation Code for Propane Burning Appliances and Equipment,"

(5) Evaporative cooling sections or towers the main structure of which exceeds a volume of 55 m^3 shall comply with the requirements of NFPA 214-1977, "Water-Cooling Towers."

Electrostatic filters

(6) Electrostatic-type filters when used shall be installed to ensure that the electric circuit is automatically de-energized when access doors are opened.

(7) Facilities for flushing and drainage shall be provided where filters are designed to be washed in place.

Odour removal equipment

(8) When odour removal equipment of the adsorption type is used it shall be
- (a) installed to provide access so that adsorption material can be reactivated or renewed, and
- (b) protected from dust accumulation by air filters installed on the inlet side.

Fans

6.2.3.15.(1) Fans for heating, ventilating and air-conditioning systems shall be located and installed so that their operation
- (a) does not adversely affect the draft required for proper operation of fuel-fired *appliances*, and
- (b) does not allow the air in the air duct system to be contaminated by air or gases from the boiler-room or furnace-room.

Equipment installations outdoors

(2) Fans and associated air handling equipment such as air washers, filters and heating and cooling units, when installed on the roof or otherwise outside the *building*, shall be of a type suitable for outdoor use.

Protection screens or gratings

(3) Exposed drive assemblies and openings into fan housings shall be protected with substantial metal screens or gratings to prevent accidents.

SUBSECTION 6.2.4. HEATING APPLIANCES, GENERAL

Scope

6.2.4.1.(1) This Subsection applies to the design, construction and installation of
- (a) solid-fuel-fired heating systems, and
- (b) heating systems in which the rated heat input exceeds 120 kW.

(2) Where the rated heat input of heating systems or equipment does not exceed 120 kW, the requirements of Part 9 shall apply.

Enclosures and separations

6.2.4.2.(1) Fuel-fired heating *appliances* shall be located, enclosed or separated from the remainder of the *building* in conformance with Section 3.5.

Outdoor installation of appliances

(2) Fuel-fired *appliances* installed on the roof of a *building* or otherwise outside the *building* shall be
- (a) *acceptable* for such location,
- (b) installed not closer that 1.2 m measured horizontally from the property line, and
- (c) installed at least 3 m from an adjacent wall of the same *building* when such wall contains an opening or openings within 3 *storeys* above and 5 m horizontally from the *appliance*, unless such openings are protected by a *closure* assembly having a ¾ h *fire-protection rating* determined in conformance with Article 3.1.6.4., or by wired glass conforming to Article 3.1.6.8.

Appliances using oil, gas or electricity

(3) Heating *appliances* using oil, gas or electrical energy shall be installed so that possible movements of the *building* structure will not cause damage to the piping or equipment.

Chimney connection

(4) Heating *appliances* using solid fuel shall be connected to a *chimney* directly or by a *flue pipe* or *breeching* conforming to Section 6.3.

SUBSECTION 6.2.5. BOILERS AND FURNACES USING SOLID FUEL

General

6.2.5.1.(1) Steam and hot water *boilers* using solid fuel shall be designed, constructed and installed in conformance with the requirements of the appropriate provincial legislation or, in the absence of such legislation, with CSA B51-1975, "Code for the Construction and Inspection of Boilers and Pressure Vessels."

(2) *Boilers* and *furnaces* using solid fuel shall be installed in a room or space having
- (a) a volume sufficiently large to permit accessibility for inspection and servicing of the *appliance* and to provide clearances as required in Article 6.2.5.3., and
- (b) a permanent opening or openings providing an area of at least 3.3 mm^2/W input, connecting with the outdoors or with some space that freely connects with the outdoors. (See Appendix A.)

Mounting

6.2.5.2.(1) Except as provided in Sentences (2) to (5), every *boiler* and *furnace* using solid fuel shall be mounted
- (a) on the ground,
- (b) on a concrete floor, or
- (c) on any type of floor that is protected by 2 courses of 90 mm thick hollow masonry units arranged so that the hollow cores in the 2 courses are at right angles to each other and will permit air circulation through them.

(2) A solid-fuel-fired *boiler* or *furnace* of a type in which flame or hot gases do not come in contact with its base may be mounted on any type of floor when
- (a) the floor is protected with at least 90 mm of hollow masonry units covered with sheet metal at least 0.56 mm thick, and
- (b) the masonry units are arranged so that the hollow cores will permit air circulation through them.

(3) Except as provided in Sentence (6), a solid-fuel-fired *forced-air furnace* may be mounted on any type of floor provided the blower compartment
- (a) occupies the entire area beneath the combustion chamber and is at least 450 mm in height, and
- (b) has at least 1 metal baffle between the combustion chamber and the base of the *appliance*.

(4) Except as provided in Sentence (6), a solid-fuel-fired hot water *boiler* may be mounted on any type of floor provided the water chamber extends under the whole of the ash pit and combustion chamber, or under the whole of the combustion chamber if there is no ash pit.

(5) Except as provided in Sentence (6), a solid-fuel-fired *boiler* or *furnace* may be mounted on any type of floor provided the *boiler* or *furnace*
- (a) is mounted on legs that provide a clear space at least 100 mm high, and
- (b) is of a type in which flame or hot gases do not come in contact with its base.

(6) A floor surface of *combustible* material beneath a solid-fuel-fired *boiler* or *furnace* shall be protected by a layer of sheet metal at least 0.56 mm thick over 6 mm asbestos or asbestos millboard for a distance of at least 450 mm beyond the *appliance* on both the firing side and the side where ashes are removed, and extending at least 150 mm beyond the *appliance* on the other sides.

Clearances

6.2.5.3.(1) Except as provided in Sentence (2), the minimum clearance between *boilers* or *furnaces* using solid fuel and any *combustible* material, whether or not such material is covered with *noncombustible* material, shall conform to Table 6.2.5.A. (See Appendix A.)

(7) Every *forced-air furnace* using solid fuel shall have a supply *plenum* that extends at least 300 mm above the top surface of the heat exchanger and the limit control shall be installed in the supply *plenum* and not more than 250 mm above the top surface of the heat exchanger.

SUBSECTION 6.2.6. STOVES, RANGES, SPACE HEATERS AND SERVICE WATER HEATERS USING SOLID FUEL

Access

6.2.6.1.(1) Except for fireplaces, space heaters, solid fuel burning *stoves*, *ranges* and *service water heaters* shall be installed in a room or space sufficiently large to permit access to the *appliance* and to provide clearances as required in Article 6.2.6.2.

Mounting

(2) Except for fireplaces, the requirements for the mounting of space heaters, solid fuel burning *stoves*, *ranges* and *service water heaters* shall be as required in Article 6.2.5.2. for *boilers* and *furnaces* of similar construction.

Clearances

6.2.6.2.(1) Except as provided in Sentence (2), the minimum clearance between *stoves*, *ranges*, *space heaters* or *service water heaters* using solid fuel and any *combustible* material, whether exposed or concealed, shall conform to Table 6.2.6.A. (See Appendix A.)

Table 6.2.6.A.
Forming Part of Article 6.2.6.2.

Appliances	Minimum Clearance, mm			
	Top	Sides	Rear	Front
Stoves and *ranges* without refractory lining: fire box side other side	750	 900 450	900	1 200
Stoves and *ranges* with refractory lining: fire box side other side	750	 600 450	600	1 200
Space heaters with an air space between the outside of the fire chamber and the external casing to allow air circulation	900	300	300	1 200
Space heaters other than above	900	900	900	1 200
Column 1	2	3	4	5

Reduced clearances

(2) Where *combustible* materials are protected in conformance with the type of protection described in Table 6.2.6.B., the minimum clearance between *stoves*, *ranges*, *space heaters* or *service water heaters* using solid fuel and *combustible* material shall conform to the clearances in that Table. (See Appendix A.)

Measurement of clearances

(3) Clearances in Sentences (1) and (2) shall be measured in conformance with Sentence 6.2.5.3.(3). (See Appendix A.)

Service water heaters

6.2.6.3. *Service water heaters* using solid fuel shall conform to the requirements of the appropriate municipal or provincial legislation or, in the absence of such legislation, to the requirements of Subsection 6.1 of the ACNBC Canadian Plumbing Code 1980.

SUBSECTION 9.32.6. SERVICE WATER HEATING FACILITIES

Service water heating facilities

9.32.6.1. Where a hot water supply is required by Article 9.32.4.3., equipment shall be installed to provide to every *dwelling unit* an adequate supply of service hot water with a temperature range from 60°C to 75°C.

Distribution of service hot water

9.32.6.2. Service hot water may be distributed from a centrally located heater to supply the entire *building* or may be supplied by an individual *service water heater* for each *dwelling unit*.

Installation

9.32.6.3. Every *service water heater* and its installation shall conform to Part 6.

Storage tanks

9.32.6.4. Where storage tanks for *service water heaters* are of steel, they shall be coated with zinc, vitreous enamel (glass lined), hydraulic cement or other corrosion-resistant material.

Fuel-burning service water heaters

9.32.6.5. Fuel-burning *service water heaters* shall be connected to a *chimney flue* conforming to Section 9.21.

Heating coils

9.32.6.6. Heating coils of *service water heaters* shall not be installed in a *flue* or in a combustion chamber of a *building* heating *boiler* or *furnace* unless *acceptable* for such installations.

SECTION 9.33 VENTILATION

SUBSECTION 9.33.1. SCOPE

Ventilation

9.33.1.1. This Section applies to the ventilation of rooms and spaces in *residential occupancies* by natural ventilation and mechanical ventilation where the rated fan capacity does not exceed 2m³/s.

Mechanical ventilation

9.33.1.2. Where the rated fan capacity exceeds 2m³/s, mechanical ventilation shall conform to Part 6.

Ventilation of rooms and spaces

9.33.1.3. Ventilation of rooms and spaces in other than *residential occupancies* shall be in accordance with good engineering practice such as the procedures described in the ASHRAE Guide and Data Books and the ASHRAE Handbooks.

Ventilation of garages

9.33.1.4. A garage for parking more than 5 cars shall be ventilated in accordance with Part 6.

SUBSECTION 9.33.2. GENERAL

Ventilation of residential occupancies

9.33.2.1. Rooms and spaces in *buildings* of *residential occupancy* shall be ventilated by natural means in accordance with Subsection 9.33.3. or by mechanical means in conformance with Subsection 9.33.4., except that where a *dwelling unit* is heated with other than fuel-fired equipment within the *dwelling unit*, a mechanical exhaust system of 1 or more fans or blowers having a total capacity of at least 0.05 m³/s at a pressure differential of 2.5 mm of water shall be provided for each *dwelling unit*.

9.33.2.2. A space that contains a fuel-fired heating *appliance* shall have natural or mechanical means of supplying the required combustion air.

9.33.2.3. Where the ventilation system forms part of the heating system, Section 9.34 shall also apply.

Air contaminants

9.33.2.4. Air contaminants released within *buildings* shall be removed insofar as possible at their points of origin and shall not be permitted to accumulate in unsafe concentrations.

Exhaust ventilation system

9.33.2.5. Every *building* in which dust, fumes, gases, vapour or other contaminants tend to create a fire or explosion hazard shall be provided with an exhaust ventilation system designed to conform with Part 6, and shall be provided with explosion relief devices and vents or other protective measures to conform with Part 3.

SUBSECTION 9.33.3. NATURAL VENTILATION

Minimum natural ventilation area

9.33.3.1. The unobstructed ventilation area to the outdoors for rooms and spaces in residential *buildings* ventilated by natural means shall conform to Table 9.33.3.A. Where a vestibule opens directly off a living or dining room within a *dwelling unit* ventilation to the outdoors for such rooms may be through the vestibule.

Table 9.33.3.A.
Forming Part of Article 9.33.3.1.

NATURAL VENTILATION		
Location		Minimum Unobstructed Area
Within *dwelling unit*	Bathrooms or water-closet rooms	0.09 m^2
	Unfinished basement space	0.2 per cent of the floor area
	Dining rooms, living rooms Bedrooms, kitchens, combined rooms Dens, recreation rooms and all other finished rooms	0.28 m^2 per room or combination of rooms
Other than within *dwelling unit*	Bathrooms or water-closet rooms	0.09 m^2 per water-closet
	Sleeping areas	0.14 m^2 per occupant
	Laundry rooms, kitchens, recreation rooms	4 per cent of the floor area
	Corridors, storage rooms and other similar public rooms or spaces	2 per cent of the floor area
	Unfinished basement space not used on a shared basis	0.2 per cent of the floor area
Column 1	2	3

Protection of openings supplying natural ventilation

9.33.3.2. Openings for natural ventilation other than windows shall be constructed to provide protection from the weather and insects. Screening shall be of rust-proof material.

SUBSECTION 9.33.4. MECHANICAL VENTILATION

Mechanical ventilation

9.33.4.1. Where rooms or spaces are mechanically ventilated, the system shall be capable of providing at least 1 air change per hour. Where a kitchen space is combined with a living area, natural or mechanical ventilation shall be provided in the kitchen area.

Air from dwelling unit

9.33.4.2. No air from any *dwelling unit* shall be circulated directly or indirectly to any other *dwelling unit, public corridor* or public stairway.

Exhaust ducts from toilet room and kitchen

9.33.4.3. Except for self-contained systems that serve individual *dwelling units*, *exhaust ducts* from rooms containing water closets, urinals, lavatories, showers or slop sinks, and *exhaust ducts* serving rooms containing cooking equipment, shall not be interconnected, and shall not be connected to duct systems serving other areas of the *building*, except at the inlet of the exhaust fan. Where such a connection is made, devices shall be installed to prevent the circulation of exhaust air through the *building* when the fan is not operating.

9.33.4.4. Where a *vertical service space* contains an *exhaust duct* that serves more than 1 *fire compartment*, the duct shall have a fan located at or near the exhaust outlet to ensure that the duct is under negative pressure, and such individual *fire compartments* shall not have fans that exhaust directly into the duct in the *vertical service space*.

Contamination from exhaust outlets

9.33.4.5. Air intakes shall be located so as to avoid contamination from exhaust outlets or other sources in concentrations greater than normal in the locality in which the *building* is located.

Exhaust discharge

9.33.4.6. *Exhaust ducts* shall discharge directly to the outdoors. Where the *exhaust duct* passes through or is adjacent to unheated space, the duct shall be insulated to prevent moisture condensation in the duct.

Access to ventilation equipment

9.33.4.7. Ventilation equipment shall be accessible for inspection, maintenance, repair and cleaning. Kitchen *exhaust ducts* shall be designed and installed so that the entire duct can be cleaned where the duct is not equipped with a filter at the intake end.

Air intake shield

9.33.4.8. Outdoor air intake and exhaust outlets shall be shielded from weather and insects. Screening shall be of rust-proof material.

Automatic damper

9.33.4.9. Outdoor air intake openings into the cold air return system shall be provided with a manually operated or automatic damper. Air intake openings larger than 127 mm diam shall be equipped with a manually operated closure if the system is gravity type, or an automatic closure if the system is mechanically operated.

9.33.4.10. Except as provided in Article 9.33.4.11., every ventilating duct shall conform to the requirements of Section 9.34 for *supply ducts*.

9.33.4.11. An *exhaust duct* that serves only a bathroom or water-closet room and that is contained entirely within a *dwelling unit* or space that is common to no other *dwelling unit*, may be of *combustible* material provided the duct is reasonably air tight and constructed of a material impervious to water.

9.33.4.12. Underground ventilating ducts shall be adequately drained. Such ducts shall have no sewer connections and shall be provided with access for inspection and cleaning.

SECTION 9.34 HEATING AND AIR-CONDITIONING

SUBSECTION 9.34.1. SCOPE

9.34.1.1. This Section applies to the design and installation of cooking appliances and heating systems in which the heat input does not exceed 120 kW and to air-conditioning systems in which the rated fan capacity does not exceed $2\ m^3/s$.

Heat input exceeding 120 kW

9.34.1.2. Where the heat input of a heating system exceeds 120 kW or the rated fan capacity of an air-conditioning system exceeds $2\ m^3/s$, Part 6 shall apply.

SUBSECTION 9.34.2. GENERAL

Design

9.34.2.1. The design, including heat loss and heat gain calculations, for the construction and installation of heating and air-conditioning systems, shall conform to good engineering practice such as the procedures described in the ASHRAE Guide and Data Books, the ASHRAE Handbooks, the HRA Digest and the Hydronics Institute Manuals.

Access to equipment

9.34.2.2. Equipment forming part of a heating or air-conditioning system except for concealed or embedded pipes or ducts shall have easy access for inspection, maintenance and cleaning.

Installation codes

9.34.2.3. Oil-burning, gas-burning and electric equipment shall be installed to conform to the following:

CSA B51-1975, "Code for the Construction and Inspection of Boilers and Pressure Vessels,"
CSA B52-M1977, "Mechanical Refrigeration Code,"
CSA B139-1976, "Installation Code for Oil Burning Equipment,"
CAN1-B149.1-78, "Installation Code for Natural Gas Burning Appliances and Equipment,"
CAN1-B149.2-78, "Installation Code for Propane Burning Appliances and Equipment," and
CSA C22.1-1978, "Canadian Electrical Code, Part I."

9.34.2.4. Except as provided in Subsection 9.34.9., the installation of solid-fuel-burning *appliances*, including mounting, clearances and requirements for safety devices, shall conform to Part 6.

9.34.2.5. Heating systems using solid fuel shall not be connected to heating systems incorporating oil or gas-burning *appliances* or electrical heating *appliances* unless the total system is *acceptable* and is designed so that unsafe temperatures will not occur with the operation of all or part of the combined system.

Temperature in residential buildings

Temperature in other buildings

9.34.2.6. Residential *buildings* intended for use in the winter months on a continuing basis shall be equipped with heating facilities capable of maintaining an indoor air temperature of 22°C at the outside winter design temperature except as provided in Article 9.34.2.7. All other *buildings* shall be equipped with heating facilities of sufficient capacity to maintain the desired indoor air temperature commensurate with the use of the *building* at the outside winter design temperature. Winter design temperatures shall be determined on the basis of the January 2½ per cent design temperature determined in conformance with Article 2.3.1.1.

Temperature in basement or cellar

9.34.2.7. Heating facilities shall be provided which shall be capable of maintaining a temperature not less than 18°C in an unfinished basement or cellar in *buildings* of *residential occupancy*. Where crawl spaces are required to be heated, the heating facilities shall be capable of maintaining a temperature of not less than 15°C.

SUBSECTION 9.34.3. HEATING SUPPLY DUCTS

9.34.3.1. Except for heating *supply ducts* serving not more than 1 *dwelling unit* and encased in concrete slabs-on-ground, heating *supply ducts* shall be *noncombustible* or shall be Class 1 ducts installed in conformance with Part 6. *Combustible* ducts in concrete slabs-on-ground that are connected to a *furnace* supply *plenum* shall be located not closer than 600 mm from that *plenum*, and not less than 600 mm from its connection to a riser or register. Ducts in or beneath concrete slabs-on-ground shall be water tight, corrosion-resistant, decay-resistant and mildew-resistant.

9.34.3.2. Galvanized steel, aluminum or tin plate *supply ducts* shall conform to Table 9.34.3.A. Other metals shall have equivalent strength and durability. Rec-

Ceiling assembly used as plenum

9.34.6.13. Except for return-air *plenums* located within a *dwelling unit*, where a ceiling assembly is used as a *plenum*, the requirements of Part 6 shall apply for such systems.

SUBSECTION 9.34.7. STEAM AND HOT WATER HEATING SYSTEMS

Steam and hot water heating system

9.34.7.1. Every steam and hot water pipe shall be constructed of *noncombustible* material having adequate strength and durability.

Insulation of pipes

9.34.7.2. Insulation or other covering for steam or hot water pipes shall be *noncombustible*, except that *combustible* insulation may be used provided such insulation conforms to the requirements in Part 6 for *combustible* pipe insulation.

Clearance for steam and hot water pipes

9.34.7.3. Clearance between steam or hot water pipes and *combustible* construction shall be at least 12 mm for steam or water temperatures greater than 90°C, but not more than 120°C, and at least 25 mm for temperatures over 120°C.

Fire stopping of pipe spaces

9.34.7.4. The space around pipes passing through a wall or floor construction shall be *fire stopped* with *noncombustible* material.

Fire-resistance rating of pipe shafts

9.34.7.5. When pipes are run in a vertical shaft, the *fire-resistance rating* of the shaft shall conform to the requirements contained in Subsection 9.10.12. Such shafts shall have a *noncombustible* lining where the pipes are not insulated.

Design for expansion and contraction

9.34.7.6. Steam and hot water pipes shall be designed to allow for expansion and contraction with changes in temperature.

SUBSECTION 9.34.8. RADIATORS, CONVECTORS AND HEAT EXCHANGERS

Heat exchangers

9.34.8.1. Every heat exchanger or *unit heater* using hot water or low pressure steam shall be installed with sufficient clearance to ensure that the temperature of any *combustible* material will not exceed its safe limit.

Protection from hot water and steam appliances

9.34.8.2. Every steam or hot water radiator or convector attached to a wall or located in a recess or concealed space containing *combustible* material shall be provided with a *noncombustible* backing.

SUBSECTION 9.34.9. STOVES, RANGES AND SPACE HEATERS BURNING SOLID FUEL

9.34.9.1. *Stoves, ranges* and *space heaters* using solid fuel shall be installed in a room or space sufficiently large to permit accessibility to the *appliance*.

Clearances

9.34.9.2. The minimum clearance between *stoves, ranges* or *space heaters* using solid fuel and *combustible* material, whether or not such material is covered with *noncombustible* material such as plaster, shall conform to Table 9.34.9.A., except that where protection is provided as described in Table 6.2.6.B. of Part 6, the clearance may be reduced in conformance to that Table.

Mounting

9.34.9.3. Except as provided in Article 9.34.9.5., a solid-fuel-fired *stove, range* or *space heater* supported on a combustible floor shall be mounted on legs that provide a clear space of at least 100 mm in height, and shall be of a type in which flame or hot gases do not come in contact with its base.

9.34.9.4. A floor surface of *combustible* material beneath a solid-fuel-fired *stove, range* or *space heater* shall be protected by a layer of sheet metal of at least 0.56 mm in thickness over 6 mm asbestos cement or asbestos millboard for a distance of at least 450 mm beyond the *appliance* on the firing side and the side where ashes are removed, and extending at least 150 mm beyond the *appliance* on the other sides.

9.34.9.5. Solid-fuel-fired *appliances* other than those described in Article 9.34.9.3. shall be mounted in conformance with Part 6.

Table 9.34.9.A.
Forming Part of Article 9.34.9.2.

MINIMUM CLEARANCES TO COMBUSTIBLE MATERIAL FOR STOVES, RANGES AND SPACE HEATERS USING SOLID FUEL

Appliances	Minimum Clearance, mm			
	Top	Sides	Rear	Front
Stoves and *ranges* without refractory lining	750	—	900	1 200
fire box side	—	900	—	—
other side	—	450	—	—
Stoves and *ranges* with refractory lining	750	—	600	1 200
fire box side	—	600	—	—
other side	—	450	—	—
Space heaters with an air space between the outside of the fire chamber and the external casing to allow air circulation	900	300	300	1 200
Space heaters other than above	900	900	900	1 200
Column 1	2	3	4	5

SUBSECTION 9.34.10. FIRE PROTECTION FOR GAS AND ELECTRIC RANGES

9.34.10.1. Except as provided in Article 9.34.10.2., a vertical clearance of at least 750 mm shall be provided above the elements or burners of electric- and gas-fired domestic ranges.

9.34.10.2. Where cabinets located above the elements or burners referred to in Article 9.34.10.1. are *noncombustible* or are protected with asbestos millboard at least 6 mm thick covered with sheet metal not less than 0.33 mm, or a metal hood with a 125 mm projection beyond the upper cabinets, the vertical clearance may be reduced to 600 mm.

9.34.10.3. *Combustible* wall framing members within 450 mm of the area where the range is to be located shall be protected above the level of the heating elements by material providing fire resistance at least equivalent to 9.5 mm thickness of gypsum board.

SECTION 9.35 ELECTRICAL FACILITIES

SUBSECTION 9.35.1. GENERAL

Electrical installation requirements

9.35.1.1. Electrical installations, including the service capacity of the installation and the number and distribution of circuits, shall meet the requirements of the appropriate provincial or municipal legislation, or in the absence of such legislation, shall conform to CSA C22.1-1978, "Canadian Electrical Code, Part I."

1985 National Building Code

9.22.1.3. Except when otherwise specifically stated herein, this Section applies to masonry fireplaces ~~constructed on site~~.

Combustion air

9.22.1.4. Fireplaces, including factory-built fireplaces, shall have a supply of combustion air in accordance with Article 9.34.2.3.

SUBSECTION 9.22.2. FIREPLACE LINERS

Fireplace liners

9.22.2.1. Except where a fireplace is equipped with a steel liner, every fireplace shall have a firebrick liner not less than 50 mm thick for the sides and back and not less than 25 mm thick for the floor.

High temperature mortar

9.22.2.2. Firebrick liners shall be laid with high temperature cement mortar conforming to CGSB 10-GP-3Ma, "Refractory Mortar, Air Setting."

SUBSECTION 9.22.3. WALL THICKNESS

Wall thickness

9.22.3.1. Except as provided in Article 9.22.3.2., the back and sides of a fireplace shall be at least 190 mm thick where a metal liner or a 50 mm thick firebrick liner is used, including the thickness of the masonry liner. Portions of the back exposed to the outside may be 140 mm thick. Joints between a firebrick liner and the adjacent back up masonry shall be offset.

9.22.3.2. When a steel fireplace liner is used with an air circulating chamber surrounding the firebox, the back and sides of the fireplace shall consist of not less than 90 mm thickness of solid masonry units or 190 mm thickness of hollow masonry units.

SUBSECTION 9.22.4. OPENINGS

Support for masonry openings

9.22.4.1. Masonry above openings shall be supported by steel lintels conforming to Article 9.20.5.3., reinforced concrete or a masonry arch.

SUBSECTION 9.22.5. HEARTH

Hearth construction

9.22.5.1. Fireplaces shall have a *noncombustible* hearth extending not less than 400 mm in front of the fireplace opening and not less than 200 mm beyond each side of the fireplace opening.

9.22.5.2. The hearth shall be supported on not less than a 140 mm thick trimmer arch of solid masonry units or not less than a 100 mm thick reinforced concrete trimmer.

SUBSECTION 9.22.6. DAMPER

Metal damper

9.22.6.1. The throat of every fireplace shall be equipped with a metal damper sufficiently large to cover the full area of the throat opening.

SUBSECTION 9.22.7. SMOKE CHAMBER

Smoke chambers

9.22.7.1. The sides of the smoke chamber connecting a fireplace throat with a *flue* shall not be sloped at an angle greater than 45° to the vertical.

9.22.7.2. The thickness of masonry walls surrounding the smoke chamber shall be at least 190 mm at the sides, front and back, except that the portions of the back exposed to the outside may be 140 mm thick.

SUBSECTION 9.22.8. FACTORY-BUILT FIREPLACES

Factory-built fireplaces

9.22.8.1. Factory-built fireplaces and their installation shall conform to ULC S610, "Standard for Factory-Built Fireplaces."

SECTION 9.33 VENTILATION

SUBSECTION 9.33.1. GENERAL

Scope

9.33.1.1. This Section applies to the ventilation of rooms and spaces in *residential occupancies* by natural ventilation and to self-contained mechanical ventilation systems serving only 1 *dwelling unit*.

9.33.1.2. Mechanical ventilation systems serving more than 1 *dwelling unit* shall conform to Part 6.

Non-residential buildings

9.33.1.3. Ventilation of rooms and spaces in other than *residential occupancies* shall conform to Part 6.

Storage garages

9.33.1.4. A *storage garage* for more than 5 cars shall be ventilated in accordance with Part 6.

9.33.1.5. Rooms or spaces in *dwelling units* shall be ventilated during the non-heating season by natural means in accordance with Subsection 9.33.2. or by a mechanical ventilation system conforming to Subsection 9.33.3.

9.33.1.6. A space that contains a fuel-fired heating *appliance* shall be provided with combustion air in accordance with Section 9.34.

SUBSECTION 9.33.2. NATURAL VENTILATION

Minimum natural ventilation area

9.33.2.1. The unobstructed ventilation area to the outdoors for rooms and spaces in residential *buildings* ventilated by natural means shall conform to Table 9.33.2.A. Where a vestibule opens directly off a living or dining room within a *dwelling unit*, ventilation to the outdoors for such rooms may be through the vestibule.

Table 9.33.2.A.
Forming Part of Article 9.33.2.1.

NATURAL VENTILATION		
Location		Minimum Unobstructed Area
Within *dwelling unit*	Bathrooms or water-closet rooms	0.09 m^2
	Unfinished *basement* space	0.2 per cent of the floor area
	Dining rooms, living rooms Bedrooms, kitchens, combined rooms Dens, recreation rooms and all other finished rooms	0.28 m^2 per room or combination of rooms
Other than within *dwelling unit*	Bathrooms or water-closet rooms	0.09 m^2 per water-closet
	Sleeping areas	0.14 m^2 per occupant
	Laundry rooms, kitchens, recreation rooms	4 per cent of the floor area
	Corridors, storage rooms and other similar public rooms or spaces	2 per cent of the floor area
	Unfinished *basement* space not used on a shared basis	0.2 per cent of the floor area
Column 1	2	3

Protection of openings supplying natural ventilation

9.33.2.2. Openings for natural ventilation other than windows shall be constructed to provide protection from the weather and insects. Screening shall be of rust-proof material.

SUBSECTION 9.33.3. MECHANICAL VENTILATION

Mechanical ventilation required

9.33.3.1. *Dwelling units* shall have a mechanical ventilation system capable of providing at least one half an air change per hour during the heating season, based on the interior finished volume of the *dwelling unit*. The system shall be controlled either manually by a switch or automatically. (See Appendix A.)

9.33.3.2. Where rooms or spaces in *dwelling units* are provided with mechanical ventilation systems in lieu of natural ventilation as required in Article 9.33.1.5., the systems shall be capable of providing at least 1 air change per hour where summer cooling is not provided or at least half an air change per hour where summer cooling is provided.

Make-up air

9.33.3.3. Mechanical ventilation systems for *dwelling units* shall include provision for introduction of fresh make-up air from the exterior.

9.33.3.4. Mechanical ventilation systems in combination with central heating or cooling systems shall conform with Part 6.

Exhaust discharge

9.33.3.5. *Exhaust ducts* shall discharge directly to the outdoors. Where the *exhaust duct* passes through or is adjacent to unheated space, the duct shall be insulated to prevent moisture condensation in the duct.

Access to ventilation equipment

9.33.3.6. Ventilation equipment shall be accessible for inspection, maintenance, repair and cleaning. Kitchen *exhaust ducts* shall be designed and installed so that the entire duct can be cleaned where the duct is not equipped with a filter at the intake end.

Air intake shield

9.33.3.7. Outdoor air intake and exhaust outlets shall be shielded from weather and insects. Screening shall be of rust-proof material.

9.33.3.8. Ventilating ducts shall conform to the requirements of Part 6 for *supply ducts*, except *exhaust ducts* that serve only a bathroom or water-closet room may be of *combustible* material provided the duct is reasonably air tight and constructed of a material impervious to water.

SECTION 9.34 HEATING AND AIR-CONDITIONING

SUBSECTION 9.34.1. GENERAL

Central heating systems

9.34.1.1. The design and installation of central heating systems shall conform to the requirements in Part 6 and to this Section.

Air-conditioning systems

9.34.1.2. The design and installation of air-conditioning systems shall conform to the requirements in Part 6.

Temperature in buildings

9.34.1.3. Residential *buildings* intended for use in the winter months on a continuing basis shall be equipped with heating facilities capable of maintaining an indoor air temperature of 22°C at the outside winter design temperature except as provided in Article 9.34.1.4. All other *buildings* shall be equipped with heating facilities of sufficient capacity to maintain the desired indoor air temperature, commensurate with the use of the *building*, at the outside winter design temperature. Winter design temperatures shall be determined in conformance with Subsection 2.2.1.

9.34.1.4. Heating facilities shall be provided which shall be capable of maintaining a temperature of not less than 18°C in an unfinished *basement* in *buildings* of *residential occupancy*. Where crawl spaces are required to be heated, the heating facilities shall be capable of maintaining a temperature of not less than 15°C.

Temperature in basement

9.34.1.5. A heating system using solid fuel shall not be connected to a heating system incorporating an oil-burning or gas-burning *appliance* or to an electrical heating device unless it can be shown that the total system is designed so that unsafe temperatures or water pressures will not occur with the operation of all or part of the combined system.

9.34.1.6. A *stove, range* or *space heater* burning solid fuel shall be connected to a *chimney* in accordance with Section 9.21.

SUBSECTION 9.34.2. STOVES, RANGES AND SPACE HEATERS BURNING SOLID FUEL

(See Appendix A.)

9.34.2.1. *Space heaters* shall conform to ULC S627/CSA B366.2, "Standard for Space Heaters for Use with Solid Fuels."

Specification

9.34.2.2. *Stoves, ranges* and *space heaters* using solid fuel shall be installed in a room or space sufficiently large to permit accessibility to the *applicance*.

9.34.2.3. Solid fuel-burning *appliances* shall be installed in a manner that ensures the complete venting of the products of combustion to the outside air. Compensation shall be made for air drawn by other *appliances* or exhaust equipment. (See Appendix A.)

Products of combustion

9.34.2.4. The minimum clearance between *stoves, ranges* or *space heaters* using solid fuel and *combustible* material, whether or not such material is covered with *noncombustible* material such as plaster, shall conform to Table 9.34.2.A., except that where protection is provided as described in Table 9.34.2.B., the clearance may be reduced in conformance to that Table (See Appendix A.)

Clearances

Table 9.34.2.A.
Forming Part of Article 9.34.2.4.

MINIMUM CLEARANCES TO COMBUSTIBLE MATERIAL FOR STOVES, RANGES AND SPACE HEATERS USING SOLID FUEL

Appliances	Minimum Clearance, mm			
	Top	Sides	Rear	Front
Stoves and *ranges* without refractory lining	1 200	—	900	1 200
fire box side	—	900	—	—
other side	—	450	—	—
Stoves and *ranges* with refractory lining	1 200	—	600	1 200
fire box side	—	600	—	—
other side	—	450	—	—
Space heaters with at least a 50 mm air space between the outside of the fire chamber and external casing to allow air circulation	1 200	600	600	1 200
Space heaters other than above	1 200	900	900	1 200
Column 1	2	3	4	5

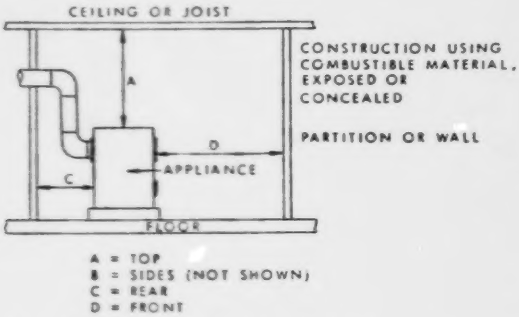
result in an equivalent level of safety, they are permitted under the provisions of Section 2.5. Where test results show that appliances must be installed with minimum clearances greater than specified in Subsection 9.34.2., the greater clearances should be maintained.

A-9.34.2.3. Combustion Air and Tight Houses. The operation of an air exhaust system or of a fuel-burning appliance removes the air from a house, creating a slight negative pressure inside. In certain cases the natural flow of air up a chimney can be reversed, leading to a possible danger of carbon monoxide poisoning for the inhabitants.

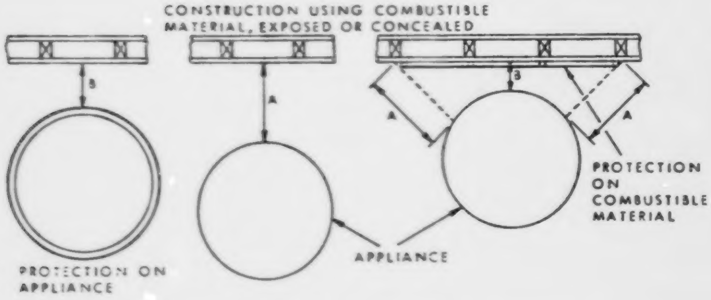
Newer houses are generally more tightly constructed than older ones because of improved construction practices, including tighter windows, weather stripping and caulking. This fact increases the probability that infiltration may not be able to supply enough air to compensate for simultaneous operation of exhaust fans, fireplaces, clothesdryers, furnaces and space heaters.

Further information is available in Canadian Building Digest 222, "Airtight Houses and Carbon Monoxide Poisoning," available from the Division of Building Research, National Research Council of Canada, Ottawa K1A 0R6.

A-9.34.2.4. and A-9.34.2.6. Minimum Clearances for Stoves, Ranges, Space Heaters and Service Water Heaters Using Solid Fuel.


CEILING OR JOIST
CONSTRUCTION USING COMBUSTIBLE MATERIAL, EXPOSED OR CONCEALED
A
D
PARTITION OR WALL
APPLIANCE
C
FLOOR
A = TOP
B = SIDES (NOT SHOWN)
C = REAR
D = FRONT

(a) BASIC CLEARANCES (TABLE 9.34.2.A.)


CONSTRUCTION USING COMBUSTIBLE MATERIAL, EXPOSED OR CONCEALED
B
A
B
A
A
PROTECTION ON COMBUSTIBLE MATERIAL
APPLIANCE
PROTECTION ON APPLIANCE

A = THE REQUIRED CLEARANCE WITH NO PROTECTION, SPECIFIED IN TABLE 9.34.2.A.

B = THE REDUCED CLEARANCE PERMITTED IN ACCORDANCE WITH TABLE 9.34.2.B.

(b) CLEARANCES WITH PROTECTION (TABLE 9.34.2.B.)

B139-1976 Installation Code for Oil Burning Equipment

CSA STANDARD B139–1976

INSTALLATION CODE
FOR
OIL BURNING EQUIPMENT

PUBLISHED, MARCH, 1976
BY THE
CANADIAN STANDARDS ASSOCIATION
(INCORPORATED 1919)
178 REXDALE BOULEVARD,
REXDALE, ONTARIO, CANADA
M9W 1R3

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B139–1976

INSTALLATION CODE
FOR
OIL BURNING EQUIPMENT

1. SCOPE

1.1 Scope

1.1.1 This Code covers minimum requirements for the installation of, alteration to, or addition to, and provision for maintenance of oil burning equipment including: supply tanks, piping, pumps, and control devices; also accessories and the heating distribution system insofar as these affect the proper operation of the oil burning equipment.

1.1.2 This Code applies to the installation of all stationary and portable oil burning equipment except equipment installed in refineries, appliances installed in mobile housing, recreational vehicles, and marine craft; internal combustion engines, lamps, and such portable devices as blow torches, melting pots, and weed burners.

NOTE: *For installation of oil burning equipment in mobile housing and recreational vehicles refer to CSA Standard Z240.5, Oil Requirements for Mobile Housing and Recreational Vehicles.*

1.1.3 In the preparation of this Code, consideration has been given to the safe operation of oil burning equipment with respect to fire hazard and injury to persons and to property.

1.1.4 This Code shall not be regarded as a design specification or as an instruction manual for untrained persons.

1.2 Application

1.2.1 The installation of oil burning equipment shall be in accordance with the requirements of this Code; except when the authority administering this Code requires otherwise.

1.2.2 When the circumstances or conditions for any particular installation are such as to render the strict application of this Code impracticable, the authority administering this Code may permit such modifications as will provide a substantially equivalent degree of safety.

2. DEFINITIONS

2.1 The following definitions apply in this Standard:

Accessory means a part capable of performing an independent function or functions, certified separately from, and contributing to the operation of, the appliance or appliances that it serves;

(b) *By interrupting the electric supply circuit by means of a switch located in an accessible location near the entrance of the room where the burner is located when the oil is supplied to the burning zone by an electrically driven fuel pump.*

3.16.2 When an appliance, using a float valve, is connected to a supply tank over 9 gallons in capacity, a valve operated by a fusible link, shall be installed in the fuel line adjacent to and upstream from the float valve and the fusible link shall be installed in the same room and within 3 feet of the device and shall function at a temperature not exceeding 350°F.

3.17 Posting of Instructions. Instructions, as furnished by the manufacturer, for the care and operation of oil burning appliances shall be conspicuously posted near the appliance.

4. VENTING AND AIR SUPPLY

4.1 General

4.1.1 When an oil burning appliance is located within a building, provision shall be made to vent the products of combustion safely to outside the building and such venting shall not pass through or be installed in return air, hot air, ventilating or combustion air ducts and shafts.

4.1.2 When an oil burning appliance is located within a building sufficient air for combustion of the oil and ventilation of the appliance shall be supplied to the space wherein the appliance is located.

NOTE: *See Appendix A for information on supply of air for combustion and ventilation.*

4.2 Venting Products of Combustion

4.2.1 General. The venting facilities shall be adequate to assure no hazard from the products of combustion.

4.2.2 Chimneys

4.2.2.1 All oil burning appliances shall be connected to a chimney except those appliances which are specifically certified for other means of venting.

4.2.2.2 The installer shall inspect the chimney to ensure that the material and construction and size are suitable for the application.

4.2.2.3 The chimney, for appliances operating on natural draft, shall be capable of handling the products of combustion and of producing a draft not less than that recommended by the manufacturer of the appliance connected thereto.

4.2.2.4 An oil burning appliance depending on natural chimney draft shall be connected to an individual chimney flue used for no other appliance except as permitted by Clause 4.2.5.8.

4.2.2.5 When forced or induced draft fans are used:

(a) The chimney shall be capable of handling the flue gases when such fans are operating; and

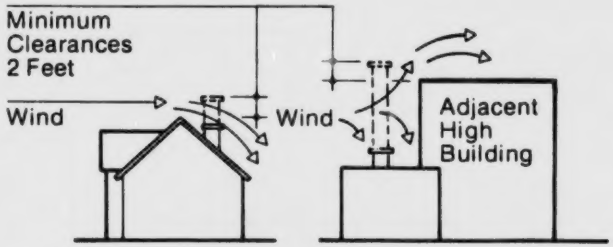
(b) Upon the failure of air-flow, the supply of fuel to the main burner shall be automatically shut off.

4.2.2.6 Masonry or concrete chimneys or metal chimneys (smoke-stacks) shall be constructed according to the requirements of the National Building Code of Canada 1975, Part 6 or Part 9 as applicable.

NOTE: *Refer to Appendix B for recommended chimney dimensions and other chimney information.*

4.2.2.7 Factory-built chimneys shall be certified and shall be installed in accordance with the manufacturer's certified instructions.

4.2.2.8 A chimney flue shall extend at least 3 feet above the highest point at which the chimney comes in contact with the roof, and not less than 2 feet above the highest roof surface or structure within 10 feet horizontally of the chimney. Not more than 8 inches of chimney flue above the top of the chimney cap may be considered in computing this height.



NOTE: *Incorrect chimney design as shown by solid lines may result in down-drafts.*

FIGURE 1

CHIMNEY CLEARANCES

4.2.3 Special Venting Arrangements. When special venting arrangements are certified for use with the connected appliance they shall be installed in accordance with the certification requirements.

4.2.4 Engineered Vent Systems. Venting systems shall be sized in accordance with good engineering practices approved by the authority administering this Code.

4.2.5 Flue Pipes

4.2.5.1 The flue pipe shall be in good condition and when used on appliances relying on natural draft it shall be:

(a) Not smaller in cross-sectional area than the flue collar of the appliance; or

(b) May be reduced in cross-sectional area to that equal to a pipe one size smaller, provided that:
  (i) Such reduction is gradual; and
  (ii) That sufficient draft is available at the appliance.

4.2.5.2 The flue pipe shall be constructed on non-combustible material and:

(a) When the flue-gas temperature is less than 750°F, the material shall be at least equivalent in structural strength and durability to galvanized steel as shown in Column 2 of Table 1; or

(b) When the flue-gas temperature is greater than 750°F, the material shall be other than galvanized steel, at least equivalent in structural strength and durability to steel as shown in Column 3 of Table 1.

TABLE 1
MINIMUM FLUE PIPE THICKNESSES

Flue Pipe Diameter Inches	Minimum Thickness Galvanized Sheet Steel Inches	Minimum Thickness for Material Other Than Galvanized Sheet Steel Inches
Up to 8	0.016 (28 ga)	0.016 (26 ga)
Over 8 – 10	0.019 (26 ga)	0.021 (24 ga)
Over 10 – 12	0.024 (24 ga)	*
Over 12	*	*

As required by acceptable engineering practices.

NOTES: 1. *These thicknesses are minimums acceptable. No reductions are permissible for rolling or mill tolerances.*

2. *When the flue pipe is installed in a location having a corrosive atmosphere, the authority administering this Code may require a thicker material.*

4.2.5.3 Joints in flue pipes shall be made mechanically secure and shall be made tight in accordance with good practice.

4.2.5.4 The flue pipe shall be installed in such a manner as:

(a) To avoid sharp turns or other construction features which would create excessive resistance to the flow of flue gases;

(b) To be as short as practicable and for natural draft burners shall not be longer than 10 feet horizontally unless otherwise approved by the authority enforcing this Code;

(c) To maintain a pitch or rise from the appliance to the chimney of at least 1/4 inch per foot of horizontal length;

(d) To extend through the chimney wall and flush with the inner face of the chimney flue;

(e) To have a clearance between the flue pipe and combustible construction of not less than the clearance required in Clause 7; and

(f) To have provisions for cleaning either by clean-outs in the flue pipe or by removal of the flue pipe.

4.2.5.5 The flue pipe shall be firmly connected to the thimble which shall be permanently cemented in place with a non-combustible material which will not crack or check.

4.2.5.6 The flue pipe shall be securely supported in position.

4.2.5.7 The flue pipe shall not pass through any floor or ceiling.

4.2.5.8 When two or more appliances, excluding incinerators and fireplaces, are connected to the same flue:

(a) The appliances shall be located on the same storey;

(b) The flue outlet pressure of each appliance shall be negative;

(c) Each appliance shall be equipped with individual draft control, unless otherwise certified, so as to maintain the over-fire pressure (draft) specified by the appliance manufacturer;

(d) The flue pipes of the appliances shall be connected directly to a common flue pipe (breeching) of adequate cross-sectional area and as close to the chimney as practicable or directly to the chimney flue in the following order:
  (i) If only oil is used, the flue pipe from the smallest appliance shall be on top;
  (ii) If different fuels are used, the gas flue pipe shall be on top, the oil flue pipe in the middle and the coal flue pipe on bottom;

NOTE: *The flue pipe from a vaporizing burner should be installed in such a manner as to prevent the extinguishing of its low or pilot fire on start up of another appliance.*

(e) The chimney flue shall be capable of venting the flue gas by natural draft when all appliances are firing at the same time; or a mechanical flue-gas exhauster (draft inducer) shall be used;

(f) Notwithstanding Clause 4.2.5.8(e) where a chimney flue vents only oil-fired appliances, two or more oil-fired appliances in excess of the chimney flue capacity may be connected to a common chimney flue providing they are equipped with a means to ensure that only the number of appliances the chimney is capable of venting shall operate at any one time simultaneously.

4.2.5.9 When the total flue-gas temperature exceeds 750°F (when determined in accordance with Clause 5.2.1.1) the flue pipe shall not pass through a combustible wall or partition.

4.2.5.10 When the total flue-gas temperature is 750°F or less (when determined in accordance with Clause 5.2.1.1) the flue pipe may pass through combustible walls or partitions, provided the construction is guarded at the point of passage by:

(a) A metal ventilated thimble not less than 12 inches larger in diameter than the pipe;

(b) A metal or burned fire-clay thimble built in brickwork or other similar materials extending not less than 8 inches beyond all sides of the thimble; or

(c) In lieu of such protection as contained in (a) and (b) all combustible material in the wall or partition shall be cut away from the flue pipe a sufficient distance to provide the clearance required as indicated in Table 3 from such flue pipe. Any material used to close up such opening shall be non-combustible insulating material.

4.2.6 Flue Pipe Dampers

4.2.6.1 A manually-operated damper shall not be placed in the flue pipe of an oil-fired appliance, except stoves using sleeve-type burners or as permitted by Clause 4.2.6.2.

4.2.6.2 Baffles and manually-operated dampers, when permitted, shall be so constructed that they shall not close off more than 80 per cent of the internal cross-sectional area of the flue pipe unless interlocked to prevent the burner from starting until the damper is fully open.

4.2.6.3 Automatically-operated dampers used to control the draft shall be designed and arranged to maintain a safe damper opening at all times, and to prevent starting of the burner unless the damper is opened at least 20 per cent of the internal cross-sectional area of the flue pipe. The damper may be fully closed when there is no demand for the burner to operate.

4.2.6.4 Other automatically-operated dampers not included in Clause 4.2.6.3 shall be designed to fully open on starting the burner and shall be so constructed that no more than 80 per cent of the internal cross-sectional area of the flue pipe can be closed off. The opening(s) shall be so located that the total area of the openings will not be substantially reduced by carbon build-up.

4.2.7 Draft Regulators

4.2.7.1 A certified draft regulator shall be installed in the flue pipe of each oil burning appliance except for:

(a) Installations using automatically-operated dampers;

(b) Appliances using sleeve-type burners; or

(c) Appliances certified for use without draft regulators.

4.2.7.2 A draft regulator, when used, shall be installed in the same room or enclosure as the appliance, and shall be located where it will not interfere with the supply of combustion air to the oil burner.

4.2.7.3 The location and the mounting of the draft regulator shall be in accordance with the recommendations of the manufacturer.

4.2.8 Heat Reclaimers

4.2.8.1 The heat reclaimer shall be certified by a nationally recognized testing agency and shall bear the mark of that agency.

4.2.8.2 A heat reclaimer shall be installed in the flue pipe from an oil burning appliance only:

(a) After the oil burning appliance has been installed and operated in accordance with the oil burning appliance manufacturer's instructions;

(b) When, after installation of the heat reclaimer, the oil burning appliance will still operate in accordance with the oil burning appliance manufacturer's instructions;

(c) Providing the following conditions exist after installation of the heat reclaimer:
  (i) The clearance to combustible construction is at least 18 inches; and
  (ii) A certified barometric type draft regulator is installed between the heat reclaimer and the chimney; and
  (iii) A minimum draft of 0.04 inch W.C. is available upstream from the heat reclaimer or there is a minimum over-fire draft of 0.02 inch W.C.; and
  (iv) The flue-gas temperature is 500°F or more upstream from the heat reclaimer and the measured temperature (total) of the flue gas at the entrance to the chimney is not less than stipulated in Clause 5.2.4.2; and

(d) When adequate air supply is provided to the burner and furnace room to compensate for the air drawn from the area through the heat reclaimer.

4.2.8.3 The installation shall comply with the requirements of the authority administering this Code.

4.2.8.4 The heat reclaimer shall not be installed within the supply or return plenum.

4.3 Air for Combustion and Ventilation

4.3.1 General

4.3.1.1 Oil burning appliances shall be installed only where:

(a) An adequate supply of combustion air is available to assure proper combustion;

(b) Ambient air temperatures are maintained within safe operating limits; and

(c) Provision is made to compensate for the air drawn from the area by other appliances such as exhaust fans, clothes dryers or fireplaces.

4.3.1.2 Oil burning appliances shall be located in such a manner as not to interfere with proper circulation of air for combustion or ventilation within the space.

4.3.1.3 When the building construction is such that normal infiltration does not meet the requirements for combustion air and ventilating air, outside air shall be introduced to the space in which the oil burning appliance is located.

NOTE: *See Appendix A for data on supply of air for combustion and ventilation.*

4.3.1.4 Each duct used to convey air from the outdoors shall have:

(a) A cross-sectional area throughout its length at least equal to the free area of the inlet and outlet openings which it connects; and

(b) A minimum dimension of 3 inches at any cross section.

NOTE: *When considering ducting or ventilating openings reference should be made to applicable building regulations.*

4.3.1.5 When an adjustable damper is provided in any opening intended to admit combustion air into the room within which the appliance is installed, the damper shall be interlocked to prevent any burner from starting before the damper is fully open.

5. TESTS

5.1 Tests and Observations. The following tests and observations shall be made, where applicable, after installation of, or after alteration to, or addition to, oil burning equipment:

(a) Determine that correct components are installed;

(b) For an atomizing type burner, observe that a nozzle of the correct spray type, capacity, and spray angle is installed. For a vaporizing type burner, determine that the flow rates are correct;

(c) Determine that the fuel pump pressure is correct;

(d) Determine that the operating controls are in satisfactory condition;

(e) Determine that the limit controls will operate properly at the correct temperature and/or pressure;

(f) Determine that the combustion safety control operates properly regarding:
  (i) Shut-off timing on flame failure; and
  (ii) Shut-off timing on ignition failure;

(g) Ensure that there is proper combustion by checking the following:
  (i) Draft in chimney, in flue outlet, and over-fire;
  (ii) Smoke density of the flue gases;
  (iii) Temperature of the flue gases;
  (iv) Analysis of the flue gases;

(h) Determine that all oil connections are tight.

NOTE: *General test methods and procedures are given in CSA Standard B140.0, General Requirements for Oil Burning Equipment.*

5.2 Requirements

5.2.1 Test Point Location

5.2.1.1 The location at which flue outlet draft and flue outlet temperature, and samples for smoke density and flue-gas analysis are to be taken, shall be:

(a) At the centreline of the flue pipe; and

(b) Not more than 18 inches downstream from the flue collar; and

(c) Between the flue collar and draft regulator, if used.

5.2.1.2 The sampling tube shall be positioned perpendicular to the flow of flue gases at the test location.

5.2.2 Draft. The flue outlet draft or over-fire draft, as applicable, shall be as specified by the manufacturer in the instructions for the equipment. The draft regulator and/or automatic dampers, when used, shall be properly adjusted and set to maintain the draft specified.

5.2.3 Smoke Density. The equipment shall operate so that the smoke density of the flue gases, as determined by the "Shell Bacharach" method, shall not exceed:

(a) A number 2 rating for equipment using Grade No. 1 and Grade No. 2 fuel oil (except for vaporizing-type burners of input capacity of 63.1 cm^3/min or less);

(b) A number 7 rating for vaporizing-type burners of input capacity of 63.1 cm^3/min or less; or

(c) A number 4 rating for equipment using other than Grade No. 1 or Grade No. 2 fuel oil.

5.2.4 Temperature

5.2.4.1 The measured flue outlet temperature (total) of the flue gases shall not exceed 750°F except when the equipment is approved for a higher temperature.

NOTE: *The temperature sensing element should be shielded from radiant heat from any source upstream from the test location.*

5.2.4.2 The measured temperature (total) of the flue gas at the entrance to the chimney shall be not less than:

(a) 350°F when less than 40 per cent of the chimney outer surface is exposed to outdoors; and

(b) 400°F when:
  (i) More than 40 per cent of the chimney outer surface is exposed to outdoors; or
  (ii) The chimney is unlined.

NOTE: *Lower flue-gas temperatures at the chimney or venting device may be permitted when adequate provisions are made for the effects of condensation.*

5.2.5 Analysis of Flue Gases. The percentage of carbon dioxide in the flue gases shall be within the limits specified in the instructions.

5.2.6 Functioning of Safety and Operating Controls. The safety and operating controls shall function within the limits specified for the type of equipment.

5.2.7 Fuel Input. The fuel input shall not exceed the fuel input specified in the instructions for the equipment.

heater, or the fuel lines between them, a suitable means shall be provided at the points of greatest stress so as to allow this motion without causing failure of the fuel lines or tank.

13.2.8 Fuel shall not be supplied to the heater by gravity and the pumping and piping arrangement shall be so arranged that in the event of the vehicle overturning, the fuel supply to the burner will shut off.

13.2.9 No heater shall be installed in such a position that a fire within the heater enclosure will block an exit way.

13.2.10 Heaters requiring electrical power for operation shall be provided with a fuse or circuit breaker and a disconnect switch shall be provided which can be operated either before or after entrance to the vehicle but before reaching the heater enclosure.

13.2.11 All automatically operated fuel-fired heaters shall be equipped with a combustion safety control which will turn off the fuel supply in the event of flame or ignition failure, and with a high limit control which will shutdown the firing side of heater in the event of overheating.

13.2.12 Manually-operated heaters shall be equipped with "tell-tale" indicator lights to indicate to the driver when the heater is operating properly.

13.2.13 Heater controls shall be located to discourage tampering by unauthorized persons and the controls shall either be located so the driver can operate them without taking his attention from the road, or shall be located where he will have to stop the vehicle and vacate the driving position to make the adjustments except that if only a manual means of shut off is available it shall be readily accessible from the driver's position.

APPENDIX A

AIR FOR COMBUSTION AND VENTILATION

NOTE: *This Appendix is not a mandatory part of this Standard.*

A1. RESIDENTIAL TYPE INSTALLATIONS

A1.1 For residential type installations and similar usages, the requirements of Clause 4.3 normally may be obtained by application of one of the methods covered in Clauses A2 and A3. For commercial and industrial equipment see Clause A5.

A2. APPLIANCES LOCATED IN UNCONFINED SPACES

A2.1 In unconfined spaces in buildings of conventional frame, brick or stone construction, infiltration normally is adequate to provide air for combustion and ventilation.

A2.2 If the unconfined space is within a building having insufficient air because of tight construction, additional air for combustion and ventilation should be obtained from outdoors or from spaces freely communicating with the outdoors. Under these conditions, permanent openings should be provided so that the total air received through them and by infiltration will be at least equal to that which would be admitted by openings having a total free area of 1 square inch per 5,000 Btu/h (28 square inches per (U.S.) gallon per hour) of total input rating of all appliances.

A3. APPLIANCES LOCATED IN CONFINED SPACES

A3.1 All Air From Inside Building. The confined space should be provided with two permanent openings, one near the top of the enclosure and one near the bottom. Each opening should have a free area of not less than 1 square inch per 1,000 Btu/h (140 square inches per (U.S.) gallon per hour) of the total input rating of all appliances in the enclosure, freely communicating with interior areas having in turn adequate infiltration from the outside. (See Figure A1.)

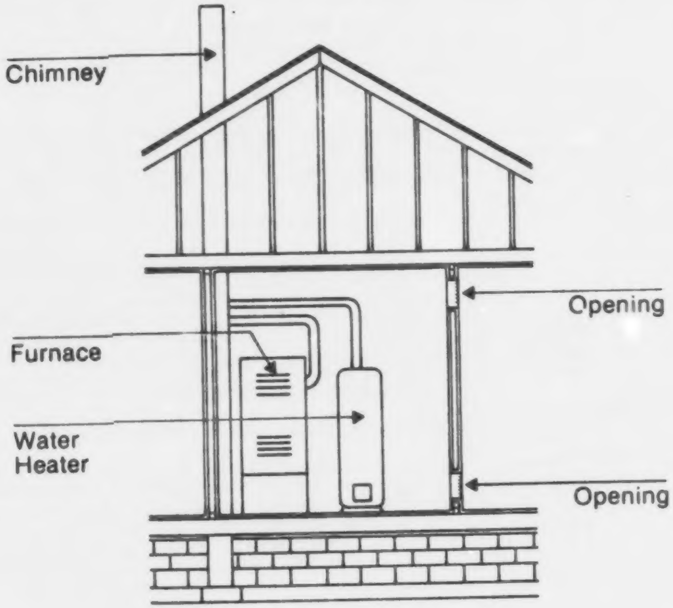

Chimney
Furnace
Water Heater
Opening
Opening

FIGURE A1

APPLIANCES LOCATED IN CONFINED SPACES, ALL AIR FROM INSIDE THE BUILDING

A3.2 All Air From Outdoors

A3.2.1 The confined space should be provided with two permanent openings, one in or near the top of the enclosure and one in or near the bottom. The openings should communicate directly, or by means of ducts, with outdoors or to such spaces (crawl or attic), that freely communicate with outdoors. (See Figures A2 and A3.)

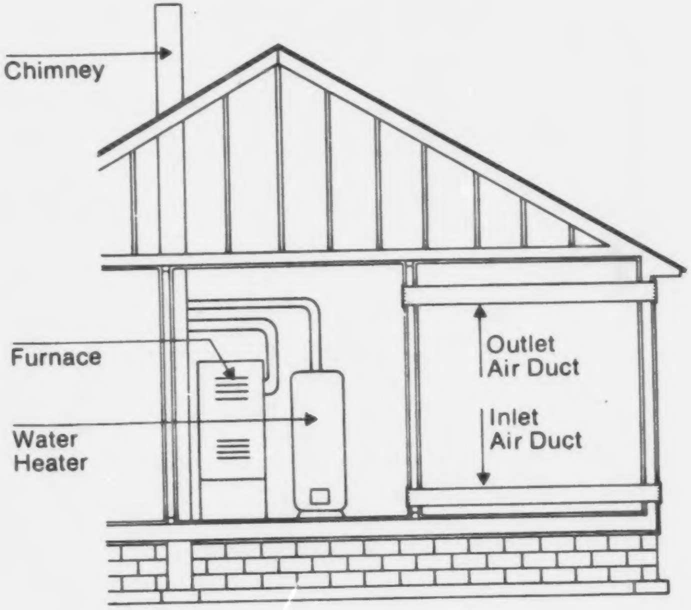

Chimney
Furnace
Water Heater
Outlet Air Duct
Inlet Air Duct

FIGURE A2

APPLIANCES LOCATED IN CONFINED SPACES, ALL AIR FROM OUTDOORS

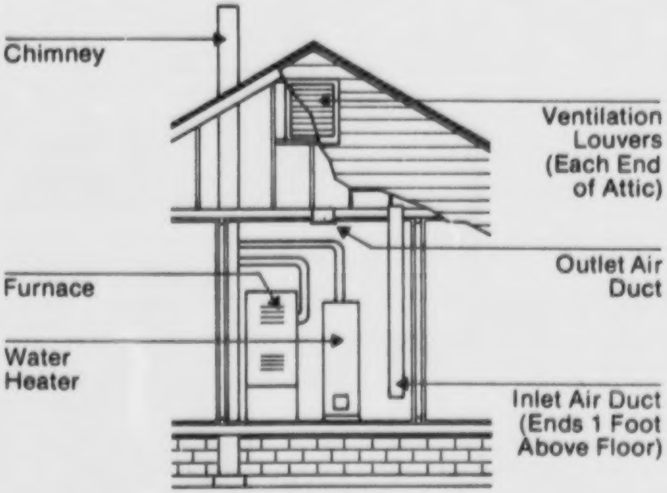

Chimney
Ventilation Louvers (Each End of Attic)
Outlet Air Duct
Furnace
Water Heater
Inlet Air Duct (Ends 1 Foot Above Floor)

FIGURE A3

APPLIANCES LOCATED IN CONFINED SPACES, ALL AIR FROM OUTDOORS THROUGH VENTILATED ATTIC

A3.2.2 When directly communicating with outdoors or by means of vertical ducts, each opening should have a free area of not less than 1 square inch per 4,000 Btu/h (35 square inches per (U.S.) gallon per hour) of total input rating of all appliances in the enclosure. If horizontal ducts are used, each opening should have a free area of not less than 1 square inch per 2,000 Btu/h (70 square inches per (U.S.) gallon per hour) of total input of all appliances in the enclosure. If the appliance room is located against an outside wall and the air openings communicate directly with the outdoors, each opening should have a free area of not less than 1 square inch per 4,000 Btu/h (35 square inches per (U.S.) gallon per hour) of the total input rating of all appliances in the enclosure.

A3.3 Ventilation Air From Inside Building — Combustion Air From Outdoors

A3.3.1 The enclosure should be provided with two openings for ventilation, located and sized as described in Clause A3.1. In addition, there should be one opening directly communicating with outdoors or to such spaces (crawl or attic) that freely communicate with outdoors. This opening should have a free area of not less than 1 square inch per 5,000 Btu/h (28 square inches per (U.S.) gallon per hour) of total input of all appliances in the enclosure. (See Figure A4.)

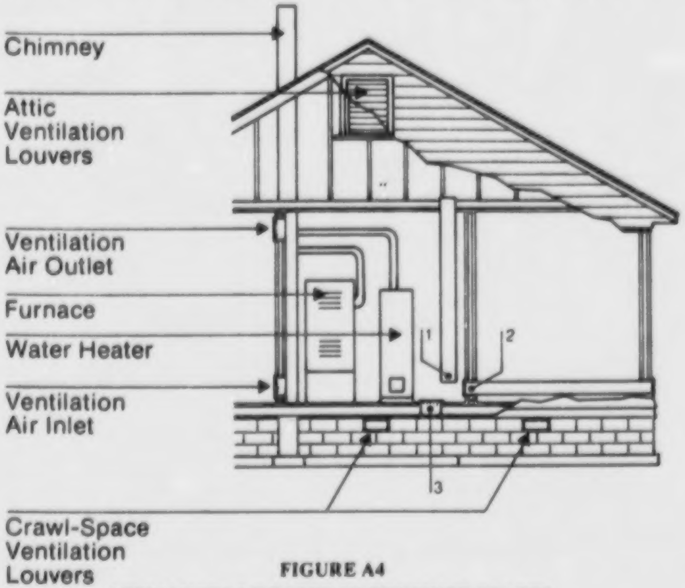

Chimney
Attic Ventilation Louvers
Ventilation Air Outlet
Furnace
Water Heater
Ventilation Air Inlet
1
2
3
Crawl-Space Ventilation Louvers

FIGURE A4

APPLIANCES LOCATED IN CONFINED SPACES, AIR FROM INSIDE BUILDING — COMBUSTION AIR FROM OUTSIDE, VENTILATED ATTIC OR VENTILATED CRAWL SPACE

NOTES:
1. *Ducts used for make-up air may be connected to the cold air return of the heating system only if they connect directly to outdoor air.*
2. *Attic ventilation louvres are required at each end of the attic with alternate air inlet No. (1).*
   Nos. (1), (2), and (3) indicate alternate locations for air from outdoors.
3. *Crawl-space ventilation louvres for unheated crawl spaces are required with alternate air inlet No. (3).*

A3.3.2 Each ventilation air opening from inside the building should have a free area of not less than 1 square inch per 1,000 Btu/h (140 square inches per (U.S.) gallon per hour) of the total input rating of all appliances in the enclosure.

A4. LOUVRES AND GRILLES

A4.1 In calculating free area in Clauses A2, A3, and A5, consideration should be given to the blocking effect of louvres, grilles, or screens protecting openings. Screens used should be not smaller than ¼-inch mesh and should be readily accessible for cleaning. If the free area through a design of louvre or grille is known, it should be used in calculating the size opening required to provide the free area specified. If the design and free area are not known, it may be assumed that wood louvres will have 20-25 per cent free area and metal louvres and grilles will have 60-75 per cent free area.

A5. COMMERCIAL AND INDUSTRIAL EQUIPMENT

A5.1 For commercial and industrial equipment, permanent facilities for supplying outside air should be provided in accordance with the following:

(a) For furnace or boiler rooms adjacent to outside walls and where combustion air is provided by natural ventilation from the outside, there should be a permanent air supply inlet having a total free area of not less than 1 square inch per 14,000 Btu/h (10 square inches per (U.S.) gallon per hour) of total input rating of the burner or burners and in no case less than 12 square inches;

(b) For furnace or boiler rooms not adjacent to outside walls the combustion air should be supplied in a manner acceptable to the authority administering this Code.

(c) When ducts are used, the inlet air duct should terminate in a location where freeze-up possibility of steam or water pipes, electrical or mechanical equipment, is reduced to a minimum.

A6. SPECIALLY ENGINEERED INSTALLATIONS

A6.1 The size of combustion air openings specified in Clauses A2 to A5 should not necessarily govern when special engineering methods approved by the authority administering this Code assure an adequate supply of air for combustion and ventilation.

APPENDIX B

INFORMATION CONCERNING THE SUITABILITY OF MASONRY, CONCRETE OR FACTORY-BUILT CHIMNEYS AND FLUES

(Refer to Clause 4.2.2)

NOTE: *This Appendix is not a mandatory part of this Standard.*

B149-1980 Installation Code for Natural Gas Burning Appliances and Equipment

CAN1-B149.1-M80

INSTALLATION CODE FOR NATURAL GAS BURNING APPLIANCES AND EQUIPMENT

1. SCOPE

1.1 General

1.1.1 This Code applies to the installation of

(a) *appliances, equipment, components* and *accessories* where gas is to be used for fuel purposes and

(b) piping and tubing systems extending from the termination of the utility installation.

1.1.2 This Code does not apply to

(a) marine or pipeline terminals,

(b) petroleum refineries,

(c) gas where used as a feedstock in chemical plants,

(d) utility pipeline distribution and transmission pipelines,

(e) storage and handling of liquefied natural gas or underground reservoirs for natural gas or,

(f) storage and handling of compressed natural gas.

1.1.3 Where the term gas is used, the requirements of this Code shall apply equally to and include any of the following gases or mixtures of them: natural gas, manufactured gas, or mixtures of propane gas and air.

1.1.4 Where the word "shall" is used in this Code, this indicates a requirement.

5.28 Infra-Red Heaters

5.28.1 A suspended *infra-red heater* shall be installed in accordance with the manufacturer's installation instructions.

5.28.2 An *infra-red heater* shall not be installed in a residential occupancy.

5.28.3 An *infra-red heater* of the surface combustion type shall not be installed in any area such as a gymnasium where physical damage may be incurred to the *heater*.

5.28.4 In a *garage* or aircraft hangar, the minimum clearance from the bottom of an *infra-red heater* to the upper surface of the highest aircraft or vehicle which may be housed therein shall be 50 percent greater than the *certified* clearance and this clearance shall not be less than 8 ft (2.4 m).

5.28.5 In a garage or shop area of a hangar communicating with an area where aircraft are stored or serviced, the minimum clearance from the floor to an *infra-red heater* shall be 8 ft (2.4 m).

6. AIR FOR COMBUSTION, VENTING AND VENTILATION

6.1 General

6.1.1 An *appliance* shall be installed in a location where there is a sufficient *air supply* for *combustion air, venting* and *ventilation air*.

6.1.2 An *appliance* when installed shall not interfere with the proper circulation of the *air supply*. When a *building* is so tightly sealed that infiltration does not meet the *air supply* requirements, outside *air supply* shall be provided.

6.1.3 A duct used to convey *air supply* to or from the outdoors shall be of metal or other *noncombustible* material and shall be of the same cross-sectional area as the free area of the opening to which they connect. The smaller dimension of a rectangular duct shall not be less than 3 inches (75 mm).

6.1.4 When an *air supply* is required from the outdoors, as in Clause 6.1.2, Subsection 6.2 or Clause 9.1.2 and the *air supply* is for a natural draft or a fan assisted *burner*, the bottom of the *air supply* opening or the termination of the *air supply* duct shall be not more than 18 inches (450 mm) nor less than 6 inches (150 mm) above the floor level.

6.1.5 When the input of an *appliance* or when the combined input of a number of *appliances* installed in a single enclosure is

(a) 400 000 Btuh (120 kW) or less, the *air supply* requirements shall be calculated in accordance with Subsection 6.2 or 6.3 except as provided in Subsection 6.6 or,

(b) more than 400 000 Btuh (120 kW), the *air supply* requirements shall be calculated in accordance with Subsection 9.1.

6.1.6 Responsibility for the proper and adequate *venting* of all types of *appliances* shall rest with the installer.

6.2 Appliances Located in Unconfined Spaces

6.2.1 When an *appliance* is located in an unconfined space within a *building* having insufficient infiltration, the *air supply* shall be obtained from outdoors by means of a permanent opening, or openings, having a total free area of not less than 1 inch^2 per 5000 Btuh (450 mm^2 per kW) of the total input rating of all *appliances*. The opening or openings may be connected to the cold air return of a heating system.

6.3 Appliances Located in Confined Spaces

6.3.1 When an *appliance* is located in a confined space and all the *air supply* is from inside the *building*, the space shall be provided with two permanent openings freely communicating with interior areas having, in turn, adequate infiltration from outside. The openings shall conform to the following:

(a) the lower opening shall not be more than 18 inches (450 mm) nor less than 6 inches (150 mm) above floor level and shall have a free opening of not less than 1 inch^2 per 1000 Btuh (2225 mm^2 per kW) of the total input rating of all *appliances* in the space;

(b) the upper opening shall be located as near the ceiling as is practicable, but not lower than any relief opening of a *draft hood* or *draft regulator* and shall have a free area not less than the total area of all *vents* or chimneys from the *appliances* contained therein, except for closet type installations, where the area shall be not less than that of the lower opening.

6.3.2 When an *appliance* is located in a confined space and the *air supply* is from the outdoors, the space shall be provided with two permanent openings that communicate directly to the outdoors by means of openings or ducts. The openings shall conform to the following:

(a) the lower opening shall be not more than 18 inches (450 mm) nor less than 6 inches (150 mm) above the floor level and shall have a free opening of not less than

  (i) 1 inch^2 per 2000 Btuh (1100 mm^2 per kW) of the total input rating of all *appliances* in the space when communication with outdoors is by means of a horizontal duct or,

  (ii) 1 inch^2 per 4000 Btuh (500 mm^2 per kW) of the total input rating of all *appliances* in the space when communications with outdoors is directly by an opening or by means or a vertical duct and,

(b) the upper opening shall be located as near the ceiling as is practicable, but not lower than any relief opening of a *draft hood* or *draft regulator* and shall have a free area not less than the total area of all *vents* and *chimneys* from the *appliances* contained therein, except for a closet type installation where the area shall be not less than that of the lower opening.

6.3.3 When an *appliance* is located in a confined space and the *ventilation air* is from inside the *building* and the *combustion* and *draft hood dilution air supply* is from outdoors,

(a) the space shall be provided with an opening for *ventilation* sized and located in accordance with Clause 6.3.1(b) and,

(b) one permanent *air supply* opening shall be provided for *combustion* and *draft hood dilution air* that communicates directly with outdoors. This opening shall have a free area of not less than 1 inch² per 5000 Btuh, (450 mm² per kW) of the total input rating of all *appliances* in the confined space and may be connected to the cold air return of a heating system.

6.4 Dampers, Louvres and Grilles

6.4.1 The free area for an *air supply* opening area in Subsections 6.2 and 6.3 shall be calculated by subtracting the blockage area of all fixed louvres, grilles or screens from the gross area of the opening.

6.4.2 Apertures in a fixed louvre, a grille or screen shall have no dimension smaller than 0.25 inch (6 mm).

6.4.3 A manually operated *damper* or manually adjustable louvres shall not be used.

6.4.4 An automatically operated *damper* or automatically adjustable louvre shall be interlocked so that the main *burner* cannot operate unless the *damper* or louvre is in the fully open position.

6.5 Conditions Created by Exhaust Fans or Fireplaces

6.5.1 When operation of an exhaust fan, a clothes dryer, a kitchen exhaust system or a *fireplace* may create a condition causing unsatisfactory combustion or venting of an *appliance*, provisions shall be made to overcome such conditions and shall be subject to the *approval* of the enforcing authority.

6.6 Engineered Installations

6.6.1 The requirements of *air supply* specified in Subsections 6.2 and 6.3 may be changed in an engineered installation subject to the *approval* of the enforcing authority.

6.7 Exceptions

6.7.1 When the *air supply* is provided by mechanical means, an air flow sensing device shall be installed. It shall be wired into the safety limit circuit of the primary safety control to shut off the gas in the event of *air supply* failure. When an *appliance* is not equipped with a *combustion safety control*, the restoration of the gas supply shall be by a manual reset device.

6.7.2 When all the *air supply* is provided by a *make-up air heater* and the *appliance* is interlocked with the *heater*, the requirements of Subsections 6.1 to 6.6 inclusive need not apply.

6.8 Appliance Venting

6.8.1 Every *appliance* shall be connected to an effective *chimney* or *vent* except

(a) a *radiant heater* installed in a masonry *fireplace* with an *approved* permanent opening that provides *venting*,

(b) a domestic *appliance* which is *approved* for use without a *vent*,

(c) an *appliance* installed in a *building* where adequate *ventilation* is provided by an exhaust fan, a natural draft ventilator, or by other means acceptable to the enforcing authority,

(d) an *appliance* installed for the production of carbon dioxide in a greenhouse where the rate of combustion does not exceed 3 Btuh for each ft³ (30 W per m³) of greenhouse volume and the concentration of carbon dioxide in the atmosphere does not exceed 5000 parts per million (0.5 percent) and,

(e) as provided in Subsection 6.22.

6.9 Methods of Venting Appliances

6.9.1 A *vent* or *chimney* shall be designed and constructed so as to develop a positive flow adequate to remove all *flue gases* to the outdoors.

B365-1984 Installation Code for Solid Fuel Burning Appliances and Equipment

3.8 Suitability of Equipment

Appliances shall not be connected to or used in conjunction with air distribution ductwork unless specifically approved for such installations.

3.9 Accessibility

3.9.1

A solid fuel burning appliance and equipment shall be installed to provide access for cleaning and visual inspection of heating surfaces, chimneys, and chimney connectors, and for the adjustment, servicing, and removal of motors, controls, draft regulators, and other parts requiring such attention.

3.9.2

When such access is by means of a ladder or working platform, the means of access shall be on the premises.

3.10 Electrical Features

Electrical wiring and equipment shall be installed in accordance with provincial regulations or, in the absence of such regulations, in accordance with CSA Standard C22.1, Canadian Electrical Code, Part I.

3.11 Gas, Oil, or Electric Heating Features

When gas, oil, or electric heating equipment is used with a solid fuel burning appliance and equipment, the gas, oil, or electric heating shall be installed in accordance with provincial regulations or, in the absence of such regulations, in accordance with CGA Standards CAN1-B149.1 and CAN1-B149.2 and CSA Standards B139 and C22.1, respectively.

3.12 Posting of Instructions

The installer shall record his or her name and address on the appliance in a readily visible location or with the operating instructions.

3.13 Location

A solid fuel burning appliance and equipment shall be located in a space that complies with the requirements of the National Building Code or in accordance with provincial regulations.

4. Air for Combustion and Ventilation

4.1

A solid fuel burning appliance shall be located in such a manner as not to interfere with proper circulation of air for combustion or ventilation within the space.

4.2

When the building construction is such that normal infiltration does not meet the requirements for combustion air and ventilating air, outside air shall be introduced to the space in which the solid fuel burning appliance is located in accordance with Clause 4.3.

Notes:

(1) The minimum size of openings for this purpose may be determined by trial and error to accommodate the flue characteristics, the firing rate, the building characteristics, etc. As a guide, the combustion air opening should be 0.5 times the flue collar area.

(2) A solid fuel burning appliance should be installed only where

(a) ambient air temperatures are maintained within acceptable operating limits;

(b) provision is made to compensate for the air drawn from the area by other appliances such as exhaust fans, clothes dryers, or fireplaces.

4.3

When a boiler or furnace is installed in an enclosed space, this space shall have a permanent opening or openings providing an area of at least 3.3 mm^2/w (1½ in^2/1000 Btu/h) input.

4.4

Openings required in Clause 4.3 shall
(a) connect directly to the outdoors; or
(b) connect with some space that freely connects with the outdoors; or
(c) connect into some space that allows sufficient air infiltration from outdoors.

4.5

Where a duct is used to convey air from the outdoors, it shall have a cross sectional area not less than 11 000 mm^2 (17 in^2), shall be not more than 3 m in length or the engineering equivalent, and shall not include more than two 90° elbows.

4.6

When an automatic damper is provided in any opening intended to admit combustion air, the damper shall be interlocked to prevent any appliance from starting before the damper is open.

5. Venting Products of Combustion

5.1 General

When a solid fuel burning appliance is located within a building, provision shall be made to vent the products of combustion safely to outside the building.

5.2 Chimneys

5.2.1

Except where certified for use with a specific chimney, a solid fuel burning appliance shall be connected to
(a) a masonry chimney conforming to provincial regulations or, in the absence of such regulations, to the requirements of the National Building Code;
(b) a factory-built chimney conforming to the requirements of ULC Standard S629.

5.2.2

Where certified with a specific chimney, the appliance shall only be used with that chimney.

5.2.3

The chimney shall be examined and inspected to ensure that the material, construction, size, and condition are suitable for the application.

Note: *See Appendix B on chimney inspection requirements.*

5.2.4

The chimney, for an appliance operating on a natural draft, shall be capable of handling the products of combustion and of producing a draft not less than that recommended by the manufacturer of the appliance connected thereto.

5.2.5

A solid fuel burning appliance shall not be connected to a chimney flue that serves an active fireplace or incinerator.

Canadian Standards
Association

CSA Standard
B366.1-M1981

Solid-Fuel-Fired Appliances for Residential Use

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3. Construction Requirements

3.1 General

3.1.1 The heat exchanger, combustion chambers, casing, and accessibility features shall comply with the requirements of CSA Standard B140.4, Oil-Fired Warm Air Furnaces, or B140.7.1, Oil-Fired Steam and Hot-Water Boilers for Residential Use, as applicable.

3.1.2 The heat exchanger, combustion chamber, and protective liners shall withstand, without significant damage, the conditions of use, fuel-charging, and ash removal.

3.1.3 The electrical and non-electrical controls and components of the appliance shall be located, protected, or constructed so that their vulnerability to physical damage during normal solid-fuel charging or ash removal is minimal.

3.1.4 Joints in heating surfaces or heat exchangers exposed to negative pressure on the circulating-air side, or on combination solid-fuel-/fuel-oil-fired appliances or on appliances equipped with a mechanical combustion-air supply, shall be continuously welded or be of equivalent airtight construction over the range of temperatures encountered in use.

3.1.5 Automatic controls shall be designed and constructed insofar as is practicable to reduce the firing rate in the event of malfunction or failure of the control or its components.

3.1.6 A control shall be so located that its response or function shall not be affected by normal activity, e.g., by the lifting of a top intended for lifting, by being covered with a pan, by being cooled by an excessive flow of combustion air, etc.

3.1.7 Solid-fuel hot-water boilers shall have provision for installation of a low-water cut-off control.

3.2 Venting

3.2.1 A solid-fuel-fired appliance shall have a means of connection to vent the products of combustion directly to the outdoors.

3.2.2 Flue-pipe dampers shall not be used, unless the appliances are certified for use with the dampers. On combination units, no manual damper will be permitted in the flue pipe servicing the oil-fired section of the appliance.

3.3 Fuelling, Charging, and Ash Removal

3.3.1 A solid-fuel-fired appliance shall have provision for fuel charging and the removal of ashes.

3.3.2 The firing and ashpit door(s) and the combustion air damper(s) shall be well-fitted and so constructed that distortion will not occur under conditions of normal use, and those used on combination solid-fuel-/fuel-oil-fired appliances shall be capable of being tightly closed.

3.3.3 The firing and ashpit door(s) shall be provided with a positive latch to hold the door(s) in a closed position.

3.3.4 The appliance shall be provided with a means to prevent the products of combustion, flame, ashes, or embers from rolling out when the firing or de-ashing doors are opened when tested in accordance with Clause 7.7.7.

3.3.5 Tools for ash removal (unless the appliance is provided with an ash pan) and stoking shall be provided with each appliance. Where a special tool is required for removal of creosote within the appliance, such a tool shall be provided with each appliance. These features may be combined in a single tool.

3.4 Combustion Air

3.4.1 A solid-fuel-fired appliance shall be equipped with a regulator, which may be a manually operated combustion-air gate or damper, to control the rate of combustion.

3.4.2 The combustion-air control shall:

(a) Not jam, bind, or be put out of adjustment during conditions of normal use;

(b) Automatically shut off the combustion-air supply in the event of regulator or linkage failure except on manual devices;

(c) Not open on manual devices on linkage failure;

(d) Have provision for manual closing; and

(e) Not attain temperatures greater than those in Item 4 of Table 2; or alternatively shall be capable of being closed by the tool required in Clause 3.3.5.

3.4.3 A solid-fuel-fired appliance shall have a means of supplying combustion air above the fuel bed. This means may be adjustable but shall have a minimum fixed opening when fully closed so as to minimize the formation of creosote.

3.4.4 A manually or automatically controlled damper in the flue pipe that does not vary the flue-passage area (e.g., check draft damper) and is intended to adjust the flue draft may be used with solid-fuel-fired appliances.

3.4.5 The burning rate of solid-fuel-fired boilers shall be automatically controlled.

(b) Be capable of being installed to operate as intended and without affecting the operation of the electrical and mechanical safety controls of the original boiler;

(c) Provide, upon completion of the installation, for a changeover from one fuel to the other without requiring the manual adjustment of any controls or components other than the thermostats;

(d) Be capable of being installed without changing the function of the controls or re-wiring of the original boiler. A wiring connection is permitted. The electrical system of both boilers shall be powered from a single branch circuit without exception;

(e) Have provision for preventing, or adequate water capacity within the boiler to prevent, damage to the boiler from loss of circulation due to electrical power failure;

(f) Be compatible with operation of a service water-heating coil within the original boiler without bypassing the operation of the solid-fuel boiler.

4.3 Stokers

4.3.1 In addition to the requirements of the preceding Clauses and insofar as it is practicable, each stoker shall be equipped with a means of preventing firing rates that would cause excessive temperatures on the surrounding construction or components of a stoker-equipped appliance, when a component on the stoker or appliance malfunctions or fails.

4.3.2 Stoker parts exposed to fire shall be at least ASTM Class 30 cast gray iron.

4.3.3 Every stoker shall be equipped with the following:

(a) At least one automatic control to regulate the normal operation of the stoker;

(b) A device for maintaining a minimum fire including outfire protection, where the coal input rate is less than 34 kg/h (75 pounds per hour);

(c) A timing device to prevent coking in the retort of an underfeed stoker;

(d) A device to stop the stoker in the event of overheating of the fuel feed tube. A warning alarm may be included.

4.3.4 The controls required by Clause 4.3.3 shall cut off the combustion-air supply and the fuel supply to the stoker-fired appliance.

4.4 Combination Solid-Fuel-/Fuel-Oil-Fired Appliances

4.4.1 The fuel-oil-burning features shall comply with CSA Standard B140.4, Oil-Fired Warm Air Furnaces, or B140.7.1, Oil-Fired Steam and Hot-Water Boilers for Residential Use, as applicable.

4.4.2 Provision shall be made to automatically close the combustion-air damper on the solid-fuel chamber whenever the oil burner is started, unless the oil-burning appliance complies with the performance requirements of the applicable CSA Standard of the B140 Series without such closure as described in Clause 8.1.4.

4.4.3 The construction shall be such that fouling of or damage to the oil burner and its controls from the solid-fuel-burning operations shall not occur.

4.4.4 The solid-fuel-charging door shall be interlocked to shut off the oil burner where flames or the products of combustion are emitted from the solid-fuel-charging opening when this door is opened while the oil burner is firing as described in Clause 8.1.4.

4.5 Solid-Fuel-Fired Outdoor-Aired Appliances

4.5.1 For the purpose of this Standard, "outdoor-aired" refers to appliances wherein all combustion air is to be taken directly from the outdoors.

4.5.2 Solid-fuel-fired outdoor-aired appliances intended for installation in mobile housing shall comply with the intent of CSA Standard B140.10, Oil-Fired Warm Air Heating Appliances for Mobile Housing and Recreational Vehicles.

4.5.3 Each appliance intended for use in mobile housing shall be suitable for installation on combustible floors.

4.5.4 The appliance intended for installation in mobile housing shall have provision for attachment to the floor.

4.5.5 The appliance shall be provided with a means for the automatic control of combustion air, which is to be drawn directly from the outdoors. The components required to convey the combustion air from the outdoors shall be provided and shipped with the appliance.

4.5.6 Means shall be provided and shipped with the appliance for conveying the products of combustion to the outdoors, together with the components required for physical support and the necessary fire-stopping and vapour-barrier integrity, unless this can be achieved with the specified, conventional, commercially available, factory-built chimney.

4.5.7 A barometric draft control shall not be used on outdoor-aired appliances.

4.5.8 All openings, including the fuel-charging door, the ashpit door, and clearances between components, where ambient air might leak into the heat exchanger or where the products of combustion might leak out shall be adequately and durably fitted to prevent more than insignificant leakage.

4.5.9 An indicator showing the approximate positioning of the combustion-air damper shall be provided in a visible location on the appliance.

5. Marking

5.1 Furnaces and Boilers. Every solid-fuel-fired furnace or boiler shall be plainly marked in a permanent manner in English and French with the following, where applicable:

(a) The manufacturer's name;

(b) The model number of the appliance;

(c) The electrical rating, where applicable, in accordance with CSA Standard C22.2 No. 3, Electrical Features of Fuel-Burning Equipment;

(d) The identity of the chimney where a specific chimney is required;

(e) The identity of the base where a specific base is required;

(f) The specific identity of each special major component where such are required; for example, a flue connector, a combustion-air duct, special mounting base, etc.;

(g) The following operating instructions:

(i) Identity of the fuel to be used, i.e., "Burn wood only" or "Burn coal only", with an identification of the particular coal type(s);

(ii) "Unsafe to fire with wood (or coal, as applicable) above this level ———— in the firing chamber", where there are no physical limitations to restrict greater loading, and the reference demarcation line shall be of a permanent nature and readily identifiable;

(iii) "Load fuel carefully or damage may result";

(iv) For combination units: "Do not attempt to light a fire when there is oil vapour present";

(v) "Do not use chemicals or fluids to start the fire";

(vi) "Do not burn garbage, gasoline, naphtha, or engine oil";

(vii) The procedure to be followed in the event of a "run-away" fire;

(viii) "Clean heat exchanger, flue pipe, and chimney as frequently as required to prevent accumulation of soot. The appliance and flue pipe must be in good condition";

(ix) Instructions on the procedure to be followed for operating the furnace without electrical power. These instructions should be emphasized by location, colour, or lettering size;

(x) Cautions regarding the storage of fuel or combustible materials within the installation clearances of the appliance;

(xi) "For safety keep firing and ashpit doors tightly closed";

(xii) "Refer to owner's manual";

(xiii) Every stoker shall be plainly marked in a permanent manner in English and French with basic operating and maintenance instructions;

(h) The following installation instructions:

(i) The installation clearances for the appliance and the ductwork and, for combination units, either a direction to refer to the clearances shown on the nameplate for the oil furnace or a duplication of clearances on each nameplate, using the maximum-minimum values for the solid-fuel- or oil-fired sections of the furnace;

(ii) The type of floor, i.e., combustible or non-combustible;

(iii) **On Furnaces**—"Not to be connected to ductwork that is still connected to another furnace" or "May be connected to ductwork that is still connected to another furnace", as applicable;

On Boilers—"Not to be connected to an existing boiler system" or "May be connected to an existing boiler system", as applicable;

(iv) "Unsafe to adjust flue draft higher than xxx", where applicable;

(i) **On Boilers.** The month and year of certification as an "add-on" model, where applicable.

as required by CSA Standard B140.4, Oil-Fired Warm Air Furnaces, at the specified static pressure and at the lowest specified fuel-oil input rate."

8.2.3 Immediately after extended power-failure operation (see Clause 7.9), the oil-burner operating control shall be bypassed in order to fire the oil burner. If necessary, the circulating medium shall be restricted, while maintaining the external static pressure until the limit control reacts to shut off the oil burner. The limit control shall be allowed to cycle the oil-burner firing until the temperatures stabilize or diminish. The temperatures shall not exceed those permitted by Operating Condition A of Table 2.

8.3 Ignition and Combustion Safety-Control Response Tests

8.3.1 During the flash fire (see Clause 7.11), when the solid-fuel fire has been developed to its brightest, the oil-burner operating control shall be adjusted to fire the oil burner.

8.3.2 If oil-burner ignition occurs, the means for ignition provided on the oil burner shall then be disconnected and, with precautions for possible delayed ignition, the oil burner shall be started and permitted to run for a few seconds. After a purging period between attempts to ignite, the duration of the oil-burner running time shall gradually be extended to the nominal flame-failure response timing (safety-switch timing) of the combustion safety control.

8.3.3 If ignition of fuel oil by the solid-fuel fire occurs, it shall not damage the appliance or any components, nor result in any burning or glowing particles being emitted from the appliance.

8.3.4 If oil-burner ignition does not occur, the solid-fuel fire shall be permitted to diminish in brightness until the oil-burner ignition can be achieved. Then the ignition-failure test shall be conducted.

8.3.5 When the flash fire begins to decline, the limit control shall be bypassed and the oil burner fired for 5 min, the fuel-oil supply then shut off, and the flame-failure response time determined. The flame-failure response time of the oil-burner combustion control shall not exceed that permitted by CSA Standard B140.2.1, Oil Burners; Atomizing-Type.

9. Tests—Outdoor-Aired Appliances

9.1 The outdoor-aired appliance shall be installed in accordance with CSA Standard B140.10, Oil-Fired Warm Air Heating Appliances for Mobile Housing and Recreational Vehicles, and tested for compliance with the preceding Clauses of this Standard.

9.2 The appliance shall be tested with the minimum and the maximum length of chimney as recommended by the manufacturer.

9.3 There shall be no significant change in the firing rate when the appliance is subjected to the wind test of CSA Standard B140.10.

9.4 The requirements of Clause 7.7.7 shall be met with various wind conditions required by CSA Standard B140.10 when fired at a rate described by Clauses 7.3, 7.4, and 7.5.

9.5 The appliance shall comply with the rain test of CSA Standard B140.10.

9.6 The requirements of Clauses 9.1 to 9.5 are also applicable to outdoor-aired appliances installed in other than mobile homes.

10. Stokers

10.1 Various modes of malfunction or failure, within the limitations of Clause 4.3.1, of the components of a stoker or a stoker-equipped appliance shall be evaluated to determine that excessive temperatures on the components of the appliance or stoker, or on the surroundings, do not occur.

11. Solid-Fuel-Fired Warm-Air Furnaces Intended for Connection onto the Ductwork Serving an Existing Oil-Fired Warm-Air Furnace to Provide an Alternative Source of Heating (Solid-Fuel-Fired "Add-On" Furnace)

11.1 General Requirements

11.1.1 The requirements of Clause 11 are additional to those of Clauses 1 through 10 of this Standard.

11.1.2 In case of variation between the requirements of Clause 11 and the other clauses within this Standard, the requirements of Clause 11 shall govern for solid-fuel-fired add-on furnaces.

11.2 Construction Requirements

11.2.1 The solid-fuel-fired furnace shall be arranged for ease of correct assembly during installation or be shipped in one piece.

Canadian Standards Association

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(ULC S627-M1984)

Space Heaters for Use with Solid Fuels

Fire Safety and Fuel Burning Equipment

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M9W 1R3

6.6.2

All removable screens shall be provided with means to ensure that

(a) the screen remains in place during normal operation and cannot be easily displaced by dislodged fuel; and

(b) the screen fits completely over the fire viewing opening.

6.6.3

A space heater shall be provided with a means to prevent the roll-out of the products of combustion, flame, ashes or embers when the firing or de-ashing doors are opened when tested in accordance with Clause 7.8.

6.6.4

Tools for stoking and for ash removal (unless the space heater is fitted with an ashpan) shall be provided with each space heater. Where a special tool is required for removal of creosote within the space heater, such a tool shall be provided with the space heater. These features may be combined in a single tool.

6.7 Grates or Liners for Combustion Chambers

6.7.1

A space heater intended to use coal shall be equipped with an integral or detachable grate. Where the grate is detachable, its use shall be indicated in the manufacturer's operating instructions.

6.7.2

Refractory or lining in the combustion chamber shall comply with the strength test as described in Clause 7.13.

6.8 Combustion-Air Inlet (from Outdoors)

6.8.1

Where a space heater is provided with combustion air (from outdoors), the supply ducts shall be at least as large in effective area as one-half of the area of the flue, unless the duct is provided by the manufacturer as part of the unit.

6.8.2

Dampers allowing 100% closure shall be provided in air intakes which are directly connected to the outdoors.

6.9 Screens

6.9.1

Tempered soda-lime glass components showing temperature rises in excess of 200°C under any firing condition shall be provided with a fixed screen over the outer face of the glass to contain possible fragmentation. Openings in the screen shall not permit the passage of a 12 mm diameter sphere.

7. Performance

7.1 General

7.1.1

When a space heater is tested in accordance with the requirements of Clause 7 and the manufacturer's recommendations, safe temperatures shall be maintained for combustible construction adjoining the space heater and the chimney connector and in the floor area surrounding and below the heater; no part shall attain a temperature sufficient to damage required corrosion protection or to cause creeping distortion, sagging, or similar damage; resistance to damage by handling shall be demonstrated; and the creation of draft by normal thermal effects shall prevent the spillage of products of combustion from the fire chamber opening. The temperatures of the outer surface of the glass components shall not exceed the design limits for the materials used.

7.2 Test Installation

7.2.1

Tests shall be conducted as described in Clauses 7.2.2 through 7.2.13 on each type of space heater. If the space heater is manufactured in more than one size, tests shall be conducted on as many sizes as may be deemed necessary to determine conformance with the requirements of Clause 7.

7.2.2

The test space heater shall be erected in a structure similar to that illustrated by Figure 1, constructed to accommodate the space heater as it is to be tested.

7.2.3

The test assembly shall be erected within a room which is reasonably free of drafts. The chimney connector shall be exhausted to a system as shown in Figure 1A. Provision shall be made for an adequate supply of make-up air to the test area. The room shall be such that during any one test the room temperature is not likely to increase more than 11°C above that at the beginning of the test.

11.1.5

All openings, including the fuel-charging door, the ashpit door and clearances between components where ambient air might leak into the heat exchanger, or the products of combustion might leak out, shall be adequately and durably sealed to prevent more than insignificant leakage.

11.2 Chimney

11.2.1

The chimney shall comply with the ULC Standard S629, Standard for 650° C Factory-Built Chimneys.

11.2.2

The chimney shall be such that it can be attached directly to the space heater and be capable of extending 900 mm above the part of the roof through which it passes. The chimney shall be at least 600 mm above the highest required elevation of any part of the mobile home within 3 m of the chimney.

11.2.3

All roof-chimney terminations shall be capable of readily being removed and reinstalled without special tools or instructions.

11.2.4

The chimney termination above the roof line shall be such that the chimney can readily be added to or extended to increase the height of the roof.

11.3 Dampers

11.3.1

Dampers allowing 100% closure shall be provided in the air intake, and shall be interlocked with the flue damper such that opening of the flue damper will cause opening of the air damper.

11.3.2

An indicator showing the approximate positioning of the combustion-air damper shall be in a visible location as part of the space heater.

11.4 Outdoor Combustion-Air Inlet

11.4.1

A space heater shall have a combustion-air inlet(s) at least as large in effective area as one-half of the area of the flue. This air inlet shall be designed to prevent material from dropping into the area beneath the mobile home, and to prevent rodents from entering from the outside. The air inlet shall be designed to permit zero clearance to combustible construction.

12. Performance

12.1 Test Installation

12.1.1

Tests shall be conducted as described by the following on each kind of space heater. If the space heater is manufactured in more than one size, tests shall be conducted on as many sizes as may be deemed necessary to determine conformance with this Standard.

12.1.2

The test space heater shall be erected in a structure similar to that illustrated by Figure 8, constructed to accommodate the space heater as it is to be tested.

12.1.3

The test assembly shall be erected within a room which is reasonably free of drafts. The chimney shall exhaust into the same space or into a space freely communicating with that from which the combustion air is taken. The room shall be such that during any one test the room temperature is not likely to increase more than 11° C above that at the beginning of the test.

12.1.4

Ventilating or cooling air openings into the space heater shall be sealed unless

(a) the openings are more than 40 mm above the floor and are so arranged that accidental closure is unlikely; and

(b) the openings are unlikely to be blocked by the user to overcome a nuisance (such as downdrafts, a cold room or an overheated room).

12.1.5

That part of the test structure representing the living-space area in which the space heater is to be installed shall be a 2.4 m wide by 2.4 m long by 2.1 m high enclosure consisting of a back wall, 2 side walls, a combustible floor, and a roof and ceiling construction above.

12.1.6

The combustible floor below the space heater shall consist of a layer of 19 mm thick particleboard or plywood over 38 mm by 89 mm floor supports, with a layer of 9.5 mm thick plywood on the lower surface of the supports.

12.1.7

The side walls and back wall shall be 38 mm by 89 mm stud walls covered with 6 mm thick plywood on both sides. The outer surface may be clad with aluminum. The walls shall be painted mat black.

12.4 Simulated Wind Test

12.4.1 Test Requirements

12.4.1.1

The operation of the appliance shall be safe and reliable under the conditions specified in Clause 12.4.2. The temperature rise of the enclosure and components of the appliance shall not exceed the maximum specified in Table 1, Column 1 for the material employed. Flame roll-out shall not exceed the limits of Clause 7.8.5.

12.4.2 Test Procedure

12.4.2.1

The appliance shall be set inside a test enclosure built to simulate the configuration of a typical mobile home (see Figure 8). During the Crib Fire Temperature Test of Clause 7.6, a wind velocity shall be produced by a blower having sufficient capacity to develop a 65 km/h wind. This wind velocity shall be directed across the combustion air inlet and the outlet of the flue vent simultaneously. The appliance shall be installed with either one side or back wall against the outside wall of the test enclosure at the manufacturer's recommended clearances.

12.4.2.2

The wind directions and the wind angles shall be in accordance with those shown in Figure 9.

12.4.2.3

The point of measurement (see Figure 9) of the wind velocities shall be taken 760 mm from

(a) the vertical centreline of the outlet of the flue vent and one-half the distance between the outlet and the roof surface; and

(b) the vertical centreline of the combustion air inlet opening and one-half the distance between the inlet and the ground surface.

12.4.2.4

The appliance shall be subjected to wind velocities

(a) fluctuated between 50 and 65 km/h; and

(b) of 16 km/h and of 32 km/h.

12.4.2.5

The duration of each cycle of air fluctuating between 50 and 65 km/h shall be approximately 30 s. The crib fire temperature test shall continue until temperatures reach equilibrium.

13. Marking

13.1

In addition to the permanent marking specified in Clause 8, space heaters complying with Part B of this Standard shall bear a permanent fire-resistant marking worded as follows:

SUITABLE FOR MOBILE-HOME INSTALLATION

and

CONÇU POUR MAISONS MOBILES

and a cautionary statement to the effect that combustion-air openings are not to be obstructed.

Also, a statement worded as follows:

OPERATE ONLY WITH DOORS CLOSED.

13.2

Where specific components such as chimneys, mounting bases, etc, are required, each such component shall be marked to show the model number in a location visible after installation.

Part C

14. Catalytic Combustors—General Requirements

14.1

Space heaters which utilize catalytic combustors shall meet the following requirements as well as those contained in Part A and, where applicable, Part B of this Standard.

14.2

These requirements are additional to those contained in existing recognized Standards applicable to the appliance.

14.3

The catalytic combustor shall be large enough to pass all the flue gas released by a full fuel charge when installed on a 4.5 m high flue of the same diameter as the appliance flue collar.

14.4

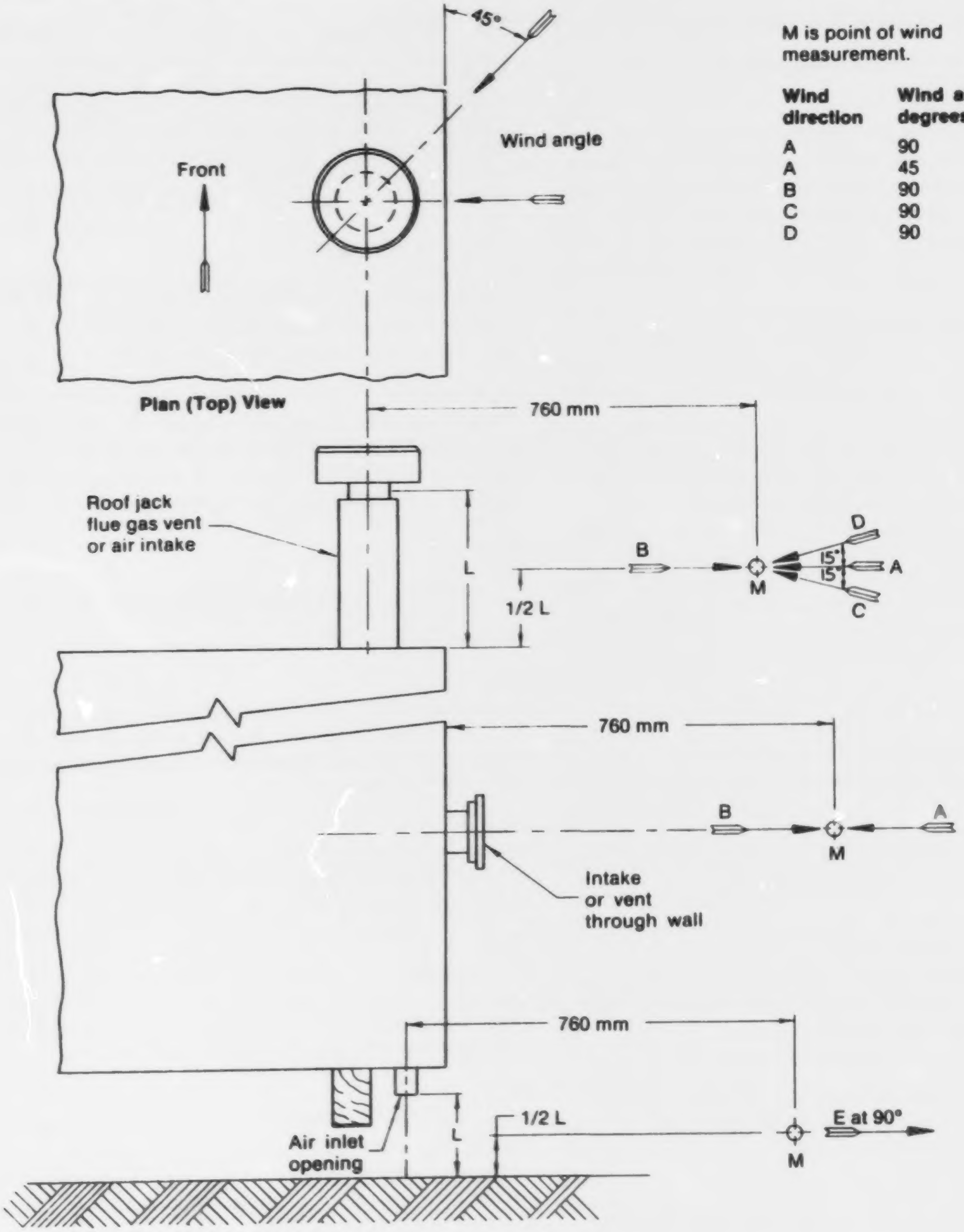
There shall be provision to by-pass the flue gas around the combustor without the necessity of having to remove the combustor, or other means to permit safe operation of the appliance should the combustor become blocked.

14.5

The resistance to flow across the combustor shall not be enough to cause constant smoke spillage when the appliance is operated on a 4.5 m flue with the fire door and the combustor by-pass open.

M is point of wind measurement.

Wind direction	Wind angle degrees
A	90
A	45
B	90
C	90
D	90


45°
Wind angle
Front
Plan (Top) View
760 mm
Roof jack
flue gas vent
or air intake
L
1/2 L
B
M
D
15°
15°
A
C
760 mm
B
M
A
Intake
or vent
through wall
760 mm
Air inlet
opening
L
1/2 L
M
E at 90°
Elevation (End) View

Note: *Tests with Wind Direction E are required only when an air inlet is intended to terminate below the vehicle.*

Figure 9
Wind Direction

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STANDARD

FOR

FACTORY-BUILT FIREPLACES

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5.9 ROOF ASSEMBLIES

5.9.1 A roof assembly shall be capable of resisting, without damage or giving way, a load equivalent to 1.44 kN/m^2 of exposed area applied to any surface extending above the roof in accordance with the test method described herein. The height of a roof assembly shall be such that the flue-gas exit will be not less than 900 mm above the roof flashing.

5.9.2 A roof assembly shall be resistant to weather and condensation. A roof assembly, when installed as specified by the manufacturer, shall prevent the entrance of water and debris into the building where the chimney passes through the roof.

5.9.3 A roof assembly shall be designed so that debris is not likely to accumulate therein when such accumulation may obstruct flue-gas or cooling-air passages or remain in contact with chimney parts having temperatures exceeding the requirements for zero clearance.

5.10 FIRE SCREENS

5.10.1 A fire screen or screens, with a mesh having a maximum opening size of 6.4 mm and capable of covering all fire chamber openings, shall be furnished by the manufacturer as part of the fireplace, even though doors are provided.

5.11 HEARTH

5.11.1 Where the hearth consists essentially of refractory materials, such materials shall be backed with a continuous steel sheet.

5.12 OUTDOOR COMBUSTION AIR INLET

5.12.1 Where a fireplace is provided with combustion air inlets, the ducting to the fireplace shall be at least as large in effective area as one half of the area of the flue.

5.12.2 Dampers allowing 100% closure shall be provided in the air intakes.

5.13 DOORS

5.13.1 A fireplace may be equipped with integral door(s) or shutter(s) designed to close off the fire chamber from the living space.

5.13.2 Those portions of a handle or knob that are subjected to contact on a fireplace shall be smooth and rounded.

10. CONSTRUCTION

10.1 GENERAL

10.1.1 A fireplace shall have means provided for the secure installation of the fireplace to the floor of the mobile home.

10.1.2 The design of a fireplace shall not void the firestopping required between spaces of a mobile home when the fireplace, its chimney, and the combustion air inlet are installed in accordance with the manufacturer's instructions.

10.1.3 A fireplace shall be designed so that the combustion air is supplied directly from outdoors.

10.2 DAMPERS

10.2.1 Dampers allowing 100% closure shall be provided in the air intakes, and shall be interlocked with the flue damper such that opening of the flue damper will cause opening of the air damper.

10.3 CHIMNEY TERMINATION

10.3.1 The chimney above the roof line shall be capable of readily being removed and reinstalled without special tools or instructions.

10.3.2 The chimney termination above the roof line shall be such that the chimney can readily be added to or extended to increase the height above the roof.

10.4 COMBUSTION AIR INLET

10.4.1 A fireplace shall have combustion air inlets. The inlet ducting to the fireplace shall be at least as large in effective area as one half of the area of the flue.

11. PERFORMANCE

11.1 TEST INSTALLATIONS

11.1.1 The test fireplace is to be installed in accordance with the manufacturer's installation instructions and erected in a structure similar to that illustrated in Figure 43, constructed to accommodate the fireplace as it is to be tested.

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OIL REQUIREMENTS FOR MOBILE HOUSING
AND
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(b) Accessibility shall be as required by Clause 5.4 and shall be from outside the vehicle;

(c) Where used, the duct work to the enclosure shall comply with Clauses 10.1.1, 10.1.3, and 10.1.5; and

(d) When a furnace is installed, the circulating return air shall be ducted from inside the vehicle directly to the furnace and provision shall be made to ensure that no circulating air is picked up from the ventilated appliance enclosure.

5.9 Conversion. Oil burning appliances shall not be converted from one fuel to another unless converted in accordance with the terms of its approval.

6. AIR FOR COMBUSTION

6.1 Air for Combustion for Heating and Hot Water Appliances. In mobile housing, provision shall be made to ensure a proper supply of fresh air for combustion for other than sealed combustion system appliances located in an enclosure as outlined in Clause 5.8.2:

(a) By providing 1 square inch of free air passage for every 2,000 Btuh input; and

(b) Half of the required area shall be taken through the ceiling or within 18 inches therefrom and approximately one half shall be taken through the floor or 6 inches therefrom.

6.2 Air for Combustion for Other than Heating and Hot Water Appliances. In mobile housing and recreational vehicles, provision for a supply of fresh air to the interior for combustion shall be made by providing one square inch of free air space for every 2,000 Btuh input to all appliances not provided with complete separation of the combustion chamber. Such vent opening shall be a monitor vent or equivalent. A warning label located adjacent to the vent shall be provided and shall comply with the requirements of Clause 11.1.

6.3 Built-in Surface Oil-fired Cooking Units. These shall have air for combustion admitted to burners from outside the counter enclosure into which the units are placed.

7. VENTING

7.1 The vent of an oil burning appliance shall not terminate underneath the mobile housing or recreational vehicle.

Clause 7.2 (New) — Add the following new Clause 7.2:

7.2 The bottom of the vent cap on flue gas vents shall be a minimum distance of 2 feet above the highest point where the vent passes through the roof.

May, 1975

Z240.3.

Clause 7.2 (to be renumbered 7.3) — Add the following new paragraph and Note:

Where a vent is intended to be extended in the field the lower portion of the roof jack assembly (inner and outer where used) shall be mechanically

CSA STANDARD B140.10–1974

OIL-FIRED WARM AIR HEATING APPLIANCES FOR MOBILE HOUSING AND RECREATIONAL VEHICLES

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BY THE
CANADIAN STANDARDS ASSOCIATION
(INCORPORATED 1919)
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CSA STANDARD B140.10-1974

OIL-FIRED WARM AIR HEATING APPLIANCES FOR MOBILE HOUSING AND RECREATIONAL VEHICLES

1. SCOPE

1.1 These requirements apply to flue-connected oil-fired forced warm air heating appliances which provide complete separation of the combustion system, including the air for combustion and flue products from the atmosphere of the living space, for installation in mobile housing and recreational vehicles, irrespective of the heating capacity or the type of burner used.

1.2 This Standard applies to appliances with fuel supplies which may be located remotely or at the appliance.

1.3 An appliance which differs from that contemplated by this Standard may be examined and tested according to the intent of the Standard and if found to be substantially equivalent, may be given recognition.

1.4 An appliance which meets each separate requirement of the Standard, will not comply with the Standard as a whole if it has other features which, when examined and tested, were found to impair the intent of the Standard.

2. DEFINITIONS

2.1 In addition to the definitions contained in CSA Standard B139, Installation Code for Oil Burning Equipment, or the CSA Manual of Definitions Recommended for Use in CSA Standards for Fuel-Burning Appliances and Equipment, the following shall apply to this Standard:

Mobile housing means a mobile home, mobile industrial or commercial structure, or portable home as defined herein;

Mobile home means a dwelling for year round living, towable vehicular portable structure built on a chassis, designed to be used with or without a permanent foundation as a dwelling when connected to indicated utilities;

Mobile industrial or commercial structure means a structure not intended as a dwelling unit, towable on its own chassis and for use without a permanent foundation. Such structures are built specifically for commercial or industrial use such as construction offices, bunk houses, wash houses, kitchen and dining units, libraries, TV units, industrial display units, laboratory units, and medical clinics;

Multiple section mobile unit means a single structure composed of separate mobile units each towable on its own chassis which, when towed to the site, are coupled together mechanically and electrically to form a single structure;

Recreational vehicle means a portable structure intended as a temporary accommodation for travel, recreational, or vacational use. It has an overall length not exceeding 32 feet and overall width not exceeding 8 feet 6 inches (8½ feet) when width means the sum of the distances from the vehicle centre line to the outermost projections on each side (including door handles, water connections, etc.) when the vehicle is folded or condensed for transit. Such structures include travel trailers, motorized homes, slide-in campers, chassis-mounted campers, and tent trailers as defined herein;

4.14.4 Access panels and such insulation as need be removed for normal service and accessibility shall be designed so that repeated removal and replacement will not cause damage or impair insulating value.

4.15 Safety Controls

4.15.1 An appliance intended for installation with standard clearances* shall be provided with a suitable temperature safety limit control suitable for the appliance to prevent the outlet air temperature from exceeding 250F, when the equipment is tested in accordance with the provisions of the Limit Control Performance Test of Clause 7.4.

**As specified in CSA Standard B139, Installation Code for Oil Burning Equipment.*

4.15.2 An appliance intended for installation with clearances less than those specified as standard clearances, or for installation in confined spaces with combustible construction in close proximity to the surfaces of the unit, such as in closets and alcoves, shall be provided with a suitable temperature safety limit control suitable for the appliance to prevent the outlet-air temperature from exceeding 200F, when the equipment is tested in accordance with the provisions of the Limit Control Performance Test of Clause 7.4.

4.15.3 In accordance with Clause 7.4.1.2 the maximum temperature safety limit controls specified in Clauses 4.15.1 and 4.15.2 shall not apply to appliances equipped with and intended only for installation with special types of distribution systems (pipes or ducts) for the heated air. The temperature safety limit control shall be provided as an integral part of such appliances.

4.15.4 Temperature safety limit controls shall be provided as an integral part of the appliance and shall comply with CSA Standard B140.0.

4.15.5 The primary safety control shall comply with the applicable requirements of CSA Standards B140.0, General Requirements for Oil Burning Equipment, B140.1, Vapourizing-Type Oil Burners, and B140.2.1, Oil Burners; Atomizing-Type, and shall be of a type suitable to the type of appliances contemplated by these requirements.

4.15.6 Baffles designed to affect the operation of a temperature limit control shall be:

(a) Rigid when mounted in the intended position; and

(b) Securely supported to prevent damage or misalignment during shipment, installation, or use.

4.16 Combustion Air and Dilution Air Intakes

4.16.1 When primary air adjustment is provided, the adjustment means shall be designed so that the flow of primary air can be controlled to provide proper flame characteristics.

4.16.2 When air for combustion is drawn through removable panels, such panels shall be designed so as to prevent their being attached in an improper position, or being interchanged with other panels on the same unit in a manner that may interfere with its performance.

4.16.3 Air shutters shall be constructed of a rust-resisting material, or have a rust-resisting finish, except when the type of material or construction employed will prevent sticking or corroding in position.

4.16.4 Sheet metal in shutters shall be of a thickness not less than 0.0254 inch. If sheet metal air shutters are of a thickness less than 0.0508 inch they shall have the outer edge turned at right angles or be otherwise properly reinforced.

NOTE: *Shutters confined or protected by a metal enclosure and not subject to distortion or damage may have .0254 inch thickness without formed edges.*

4.16.5 When tap bolts are used to attach air shutters, or other parts which must be removed for normal servicing or replacement, they shall be made of rust-resisting material, or if of steel, shall have a rust-resisting coating.

4.16.6 An air-intake assembly:

(a) To the underside of a mobile housing or recreational vehicle shall be designed to extend at least one inch below the lowest surface of the floor structure;

(b) Through the roof of a mobile housing or recreational vehicle shall be designed so that, when the assembly is installed as intended, the air entrance will be at least 6 inches above the top surface of the roof and the exit at least flush with the lowest surface of the ceiling at that point; and

(c) To be installed through an outside wall of a mobile housing or recreational vehicle shall be capable of being extended from 1½ inches to 4¾ inches beyond the inside face of the wall and shall not project beyond the outside wall more than 3 inches.

4.16.7 An entrance of an air-intake assembly shall be guarded, shielded, or located to exclude rain, snow, debris, and birds. A screen, if used, shall have a mesh of not less than ¼ inch. A louvre, if used, shall have openings that will pass a rod of ¼ inch diameter.

4.16.8 The free area of openings to the outdoors in combustion air and dilution air-intake assemblies to be installed in the wall of an enclosure in which an appliance is to be installed shall be not less than 1 square inch for each 5,000 Btuh of the total input rating of the appliance.

4.16.9 The minimum cross-sectional dimension of an internal air passage in an air-intake assembly shall be not less than ½ inch.

4.16.10 If an automatic operated air control is provided, the arrangement shall be such that, in case of failure, safe combustion shall continue or the fuel shall be shut off forthwith.

4.16.11 An appliance equipped with a forced or induced draft fan, or both, shall be arranged to assure safe combustion or to shut off the fuel supply forthwith upon failure of the air supply.

4.16.12 Furnace operations shall not be adversely affected by such negative pressures as may be developed in the burner compartment due to such conditions as restricted air filters or returned circulating air supply.

4.17 Means of Ignition

4.17.1 Where ignition of the burner cannot be readily achieved without the aid of a lighting torch, such a torch shall be provided together with provision for its storage.

8.2.4 For forced-air furnaces the appropriate external static pressure specified in Clause 7.1.7 to be measured at the supply plenum shall be maintained while normal equilibrium operating temperatures are being established.

8.2.5 The applicable conditions specified in Clause 7.6.2.8 shall be observed throughout each test.

8.2.6 Each test shall be conducted after normal equilibrium operating temperatures have been established for the appliance.

8.2.7 Each test shall be continued with the appliance cycling on the temperature safety limit control, unit equilibrium or receding temperatures are attained.

8.2.8 For each of these tests, the maximum temperature attained during the period beginning immediately following the first shut-off affected by the temperature safety limit control, and terminating one hour after the first shut-off shall be within these temperature limits prescribed for abnormal operation in CSA Standard B140.0, General Requirements for Oil Burning Equipment.

8.2.9 For each of these tests, the maximum temperature attained during the one hour period specified in Clause 8.2.8 at the walls, floors, (except for units intended for placement on non-combustible floors), overhead structures, or other combustible surfaces of the test enclosure adjacent to the furnace, shall not exceed 252F, based on a nominal room ambient temperature of 77F.

NOTES: 1. *For units intended for placement on combustible floors, the temperature limit specified in Clause 8.2.9 applies to the floor beneath and within 3 feet of the appliance base, or plenums and ducts where applicable.*

2. *The temperature limit specified in Clause 8.2.9 applies to overhead structures above and within 3 feet of the appliance, plenums and ducts, where applicable.*

8.2.10 For appliances intended for installation with no (zero) clearance to the surrounding combustible construction of the enclosure, the temperature limit specified in Clause 8.2.9 shall apply to the outer casing of the appliance being tested.

8.2.11 Following the one hour period specified in Clause 8.2.8 for each test, the temperatures referred to in Clauses 8.2.8, 8.2.9, and 8.2.10 shall not exceed the limits specified for normal operation in CSA Standard B140.0.

NOTE: *The degree of hazard involved, will be the basis of interpretation of Clause 8.2.11 e.g., temperature of the components located within the return air compartment may be considered as most critical due to their location in a circulating air duct system.*

8.3 Simulated Wind Test

8.3.1 Test Requirements

8.3.1.1 The ignition and operation of the appliance shall be safe and reliable under the abnormal conditions specified in Clause 8.3.2.

8.3.1.2 Under abnormal conditions only a momentary pulsation is permissible following ignition and/or shutdown.

8.3.2 Test Procedure

8.3.2.1 The appliance shall be set inside a test enclosure built to simulate the configuration of a typical mobile home (see Figure 1). A wind velocity shall be produced by a blower having sufficient capacity to develop a 40 mile per hour wind. This wind velocity shall be directed across the combustion air inlet and the outlet of the flue vent simultaneously. The appliance shall be installed with either one side or back wall against the outside wall of the test enclosure at the manufacturer's recommended clearances.

8.3.2.2 The wind directions and the wind angles shall be in accordance with those shown in Figure 4.

8.3.2.3 The point of measurement, (see Figure 4) of the wind velocities shall be taken 30 inches from:

(a) The vertical centreline of the outlet of the flue vent and one-half the distance between the outlet and the roof surface; and

(b) The vertical centreline of the combustion air inlet opening and one-half the distance between the inlet and the ground surface.

8.3.2.4 The appliance shall be subjected to wind velocities:

(a) Fluctuated between 30 to 40 miles per hour; and

(b) Of 10 miles per hour and of 20 miles per hour.

8.3.2.5 The duration of each cycle of air fluctuating between 30 and 40 miles per hour shall be approximately thirty seconds. The test shall continue until combustion reaches equilibrium.

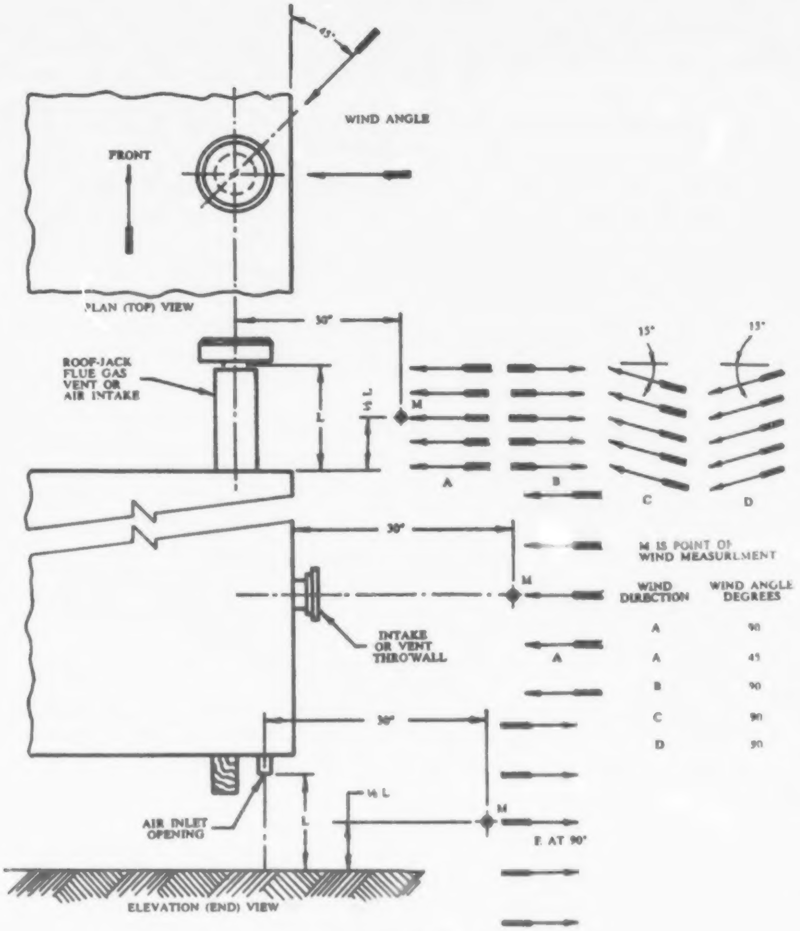
8.3.2.6 With the appliance operating under the above wind conditions the burner shall ignite and operate in a reliable manner.

8.4 Abnormal Voltage

8.4.1 The ignition and operation of appliances equipped with electrical features shall be safe and reliable at any voltage between 70 and 110 per cent of rated voltage.

NOTE: *Refer also to Clause 9 on burner tests.*

8.4.2 For the purpose of this test, the rated voltage shall be 120 volts for "rated" voltages of 110 to 120 volts; and 240 volts for "rated" voltages of 220 to 240 volts.


45°
WIND ANGLE
FRONT
PLAN (TOP) VIEW
30"
15°
15°
ROOF-JACK FLUE GAS VENT OR AIR INTAKE
L
½ L
M
A
B
C
D
30"
M
M IS POINT OF WIND MEASUREMENT
INTAKE OR VENT THRO'WALL
A
30"
½ L
L
M
AIR INLET OPENING
E AT 90°
ELEVATION (END) VIEW

WIND DIRECTION	WIND ANGLE DEGREES
A	90
A	45
B	90
C	90
D	90

FIGURE 4

WIND DIRECTION

NOTE: *Tests with Wind Direction E are required only when an air inlet is intended to terminate below the vehicle.*

8.5 Flooding

8.5.1 The flooding test shall be applied to appliances equipped with vaporizing burners.

8.5.2 Fuel shall not be discharged from the burner with the appliance level and when the fuel in the burners has been increased ¾ inch above the operating level in the fuel level regulating device. In cases where the relationship between the burner and the fuel regulating device is difficult to determine, then the ¾ inch shall be increased to 1 inch.

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Z240.4.1-M1983

Installation Requirements for Gas Burning Appliances in Mobile Homes

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6. Air Supply for Other than Direct Vent Appliances

6.1 Air for Combustion and Ventilation for Furnaces and Hot Water Appliances. Provision shall be made to ensure a proper supply of fresh air for combustion and ventilation as follows:

(a) By providing adequate free air passage as recommended by the appliance manufacturer in accordance with the appliance certification;

(b) If no recommendation is provided by the appliance manufacturer, by providing 1100 mm^2 of free area per kW input;

(c) Approximately one-half of the required area shall be taken through the roof or within 450 mm therefrom, ensuring that no portion is below the relief opening of the draft hood. The remaining one-half shall be taken through the floor or 150 mm therefrom; and

(d) An entrance of an air intake assembly shall be guarded, shielded, or located to exclude rain, snow, debris, vermin, and birds. A screen, if used, shall have a mesh of not less than 6 mm.

Note: *As an alternative to Items (a) and (b), other arrangements for providing combustion air may be used if certified for use with the appliance.*

6.2 Air for Combustion for Other than Furnaces and Hot Water Appliances. Provisions for a supply of fresh air for combustion shall be made by providing 1100 mm^2 of free area per kW input. Such openings may be a monitor vent, other windows, or by means of a roof top ventilator. A warning label in accordance with the requirements of Clause 11.1 shall be located adjacent to the opening.

6.3 Replacement Air for Gas-Fired Clothes Dryers. Provision for a supply of replacement air for gas-fired clothes dryers shall be provided in the area where the dryer is located, such opening being not less than twice the area of the dryer exhaust. A warning label as called for in Clause 6.2 shall be provided.

7. Venting

7.1 General

7.1.1 Gas burning appliances shall not vent products of combustion underneath the mobile home.

7.1.2 Vents, roof jacks, and special fittings certified as component parts of an appliance shall be installed in conformity with the terms of the appliance certification. All joints in the venting system located within the structure of the mobile home shall be readily accessible for field inspection.

7.1.3 Every joint of any vent or vent connection shall be secure, rigid, tight, and installed in a workmanlike fashion.

7.1.4 The bottom of the vent cap on flue gas vents shall be a minimum distance of 610 mm above the highest point where the vent passes through the roof.

7.1.5 Flue gas vents shall terminate at least 1.8 m from any combustion air inlet of an adjacent appliance.

7.1.6 Except for clothes dryers, a single-wall metal vent shall not be used unless it is a component part of a certified appliance or as specified in Clause 7.3.

7.2 Roof Jack Extension

7.2.1 Where a vent is to be extended in the field, the lower portion of the roof jack assembly (inner and outer where used) shall be mechanically fastened to the appliance at the mobile home factory, and the portion protruding through the roof shall be complete in every respect, including roof sealing.

7.2.2 The vent opening shall be weather-capped until the final assembly is installed.

7.2.3 A label in accordance with Clause 11.3 shall be attached to a conspicuous location adjacent to the appliance.

7.3 Cooking Appliances

7.3.1 In addition to the openings required by Clause 6.2 the area in which gas-fired cooking appliances are located shall be ventilated by an opening that

(a) Is not less than 8065 mm^2 in cross-sectional area,

(b) Has a minimum dimension of 50 mm, and

NATIONAL STANDARD OF CANADA CAN1-2.19-M81

GAS-FIRED GRAVITY AND FAN TYPE DIRECT VENT WALL FURNACES

Effective Date — January 1982

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CGA 2.19-1969

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Canadian Gas Association

Approved by
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PART I

CONSTRUCTION

1.1 SCOPE

1.1.1 This standard applies to newly produced, natural draft and fan-induced inlet-air direct vent wall furnaces and to direct vent wall furnaces with cooling units (see Part III, Definitions) constructed entirely of new, unused parts and materials. This standard applies to direct vent wall furnaces with inputs up to and including 400 000 Btuh (117.23 kW):

a. for use with natural gas,

b. for use with propane,

c. for mobile housing installation for use with propane only,

d. for recreational vehicle installation for use with propane only,

e. for mobile housing installation convertible for use with natural gas and propane when provision is made for simple conversion from one gas to the other,

f. for recreational vehicle installation convertible for use with natural gas and propane when provision is made for simple conversion from one gas to the other.

The construction of direct vent wall furnaces and direct vent wall furnaces with cooling units for use with the above-mentioned gases is covered under Part II.

The performance of direct vent wall furnaces and direct vent wall furnaces with cooling units for use with the above-mentioned gases is covered under Part II.

1.1.2 This standard applies only to automatically operated direct vent wall furnaces of the types defined in Part III, Definitions.

1.1.3 The appliance anticipated by this standard is essentially a balanced flue appliance with the air intake and vent outlet in close proximity. Other direct vent designs shall be subjected to such additional tests as believed necessary at the discretion of the testing agency.

1.2 GENERAL CONSTRUCTION

1.2.1 The construction of the appliance, whether specifically covered in this standard or not, shall be in accordance with reasonable concepts of safety, substantiality and durability. Component parts shall be well fitted and not show signs of becoming warped, bent, broken or otherwise damaged during the initial test installation or during any of the tests specified so as to prevent compliance with this standard.

All specifications as to construction set forth herein may be satisfied by the construction actually prescribed or such other construction as will provide at least equivalent performance.

1.2.2 Every part of an appliance shall be (1) designed to prevent incorrect assembly, (2) secure against displacement and (3) constructed to maintain a fixed relationship between essential parts under normal and reasonable conditions of handling and usage so as to provide continued compliance with this standard.

1.2.3 Legs or spacers necessary for compliance with section 2.19 shall be furnished by the manufacturer as an integral part of the appliance, including the vent extension and terminal. These legs or spacers shall be located so as to preclude installation of the appliance at clearances from combustible construction less than those specified by the manufacturer. See Figure 3 for examples of spacer locations on a typical appliance for mobile housing or recreational vehicle installation.

1.2.4 Optional fans for use with gravity type wall furnaces shall be provided with the appliance submitted for test. The junction box, complete wiring harness and wiring clips (when necessary) shall be provided as a part of the fan assembly, together with complete wiring diagrams.

1.2.5 A direct vent wall furnace shall be provided with the venting system as part of the appliance. Venting systems shall be provided with means for secure attachment to the appliance or wall structure as specified in section 2.23.

1.2.6 An appliance equipped with a safety screen(s) or guard(s) to protect clothing or flammable materials from contacting parts of the appliance which could easily cause ignition (see section 2.21) shall have such equipment mechanically attached to the appliance by the manufacturer.

1.2.7 Any flue gas passageway which is exposed to the return air side of the circulating air stream, and any flue gas passageway which is in the discharge air stream of an appliance having the flue gas temperature lower than 250°F (121°C) when tested under 2.12 shall be constructed of a corrosion-resistant material or have a corrosion-resistant finish to resist corrosion by condensate. Steels with coatings, such as paint suitable for the temperature and conditions to which exposed, and cast iron are considered corrosion resistant.

1.2.8 A direct vent wall furnace with a cooling unit shall have the refrigeration coil located downstream from the heating section, unless the heating section is specifically for installation downstream from the coil (see sections 1.28 and 2.27), or the coil shall be located parallel to the heating section. In those cases where the coil is located parallel to the heating section, dampers or other means used to control flow of air shall be adequate to prevent chilled air from entering the heating section. If the dampers are manually operated, means shall be provided to prevent operation of either unit unless the damper is in the full heat or cool position. Adequate means shall be provided for disposal of condensate and to prevent dripping of condensate on the heating element.

1.2.9 A direct vent wall furnace for installation at high altitudes shall comply with the applicable construction provisions off the current standard CAN1-2.17 GAS APPLIANCES FOR USE AT HIGH ALTITUDES.

1.2.10 Special construction provisions applicable to direct vent wall furnaces for mobile housing installation are specified in clauses 1.1.1 c and e, 1.2.3, 1.4.5, 1.6.18, 1.6.19, 1.8.6, 1.16.4, 1.30.2-i, 1.30.3-d, 1.30.4-b and 1.30.11.

1.2.11 Special construction provisions applicable to direct vent wall furnaces for recreational vehicle installation are specified in 1.1.1-d and -f, 1.2.3, 1.4.5, 1.6.18, 1.6.19, 1.8.6, 1.12.8, 1.16.4, 1.30.2-i, 1.30.3-d, 1.30.4-b and 1.30.11.

1.3 ASSEMBLY

1.3.1 Parts that may come in contact with the operator's hand during normal adjustment or servicing shall be free from sharp projections or edges and projected screw ends.

1.3.2 When tap bolts are used to attach air shutters, manifold supports, or other parts which must be removed for normal servicing or replacement, they shall be made of corrosion resistant material, or if of steel, shall have a corrosion resistant coating.

1.3.3 Bolts, nuts, screws, except sheet-metal screws, and other threaded parts used in the general assembly of the appliance shall have threads conforming to the current standard CSA B1.1 UNIFIED AMERICAN SCREW THREADS.

1.3.4 Fastening means used for securing parts that may need servicing shall be of a reusable type.

1.3.5 Insulating materials shall be attached by the manufacturer.

Insulating materials and their internal bonding or adhesive attachment means shall withstand temperatures and air velocities to which subjected in normal operation without displacement, damage or deterioration; or suitable mechanical attachment shall be provided.

1.3.6 Means shall be provided as an integral part of the appliance to prevent incandescent particles from falling on combustible material.

1.4 ACCESSIBILITY

1.4.1 All clauses concerning accessibility and visual checks shall be performed with the appliance installed as it would be in service in accordance with the manufacturers instructions at the specified minimum service clearances.

1.4.2 All controls shall be accessible for normal servicing and functional adjustment in position, and shall be replaceable during normal servicing. Manifold assemblies which permit removal of control(s) intact shall be considered to comply with this provision. Removal of an access panel or door to provide access to a control compartment shall be considered acceptable.

1.4.3 It shall be possible to oil the motor, blower or fan bearings, which require that lubricant be added, without dismantling or removing any portion of the venting system.

1.4.4 It is permissible to disconnect the venting system for removal of the blower assembly.

1.4.5 Controls, pilots, burners, fans, and electrical components shall be accessible for servicing and replacement. Except for appliances for mobile housing or recreational vehicle installation, this shall be accomplished from the room in which the appliance is located.

1.4.6 Heads and nuts of bolts which must be removed to permit removal of cleanout plates shall not be located so as to contact flue gases.

1.4.7 Flue baffles shall be removable for cleaning or shall be designed so that they cannot be dislodged or distorted during cleaning. Flue baffles which are removable for cleaning shall be construced to that they cannot be installed in other than the correct position.

1.4.8 The flue gas passageways through the appliance shall be accessible for cleaning. This may be accomplished by appliance disassembly or heating element removal, provided it can be accomplished by one person in reasonable time.

1.4.9 Any access door or panel which is exposed to weathering shall require the use of a tool to open.

1.5 COMBUSTION AIR AND VENTILATION

1.5.1 Cabinet compartments housing gas piping and controls shall be adequately ventilated.

1.5.2 All openings in perforated or expanded metal panels, provided over combustion air, circulating air or flue outlet openings, shall be of such size that they will permit entrance of a 1/8 inch (3.2 mm) diameter rod.

1.5.3 The construction of the appliance shall be such that when installed in accordance with the manufacturer's instructions, the combustion air supply will be in the same pressure zone as the vent outlet.

1.5.4 In the event the blower providing the draft becomes inoperative on appliances provided with induced draft or power burners, the appliance design shall be such as to prevent gas flow:

a. to the main burner(s) or

b. to the main burner(s) and pilot burner(s) when an interrupted or intermittent pilot ignition system(s) is used.

A properly applied centrifugal or sail switch, or equivalent device meets the intent of this provision. If a centrifugal switch is used, the blower shall be keyed, or the equivalent, and secured to the shaft on which the be constructed entirely of sheet metal nor depend upon friction of the joint itself for strength. Joints in heating surfaces shall be considered gastight when the direct vent complies with the test specified in section 2.24. Such joints shall be constructed so that making and breaking the connection in normal usage will not alter the effectiveness of the joint.

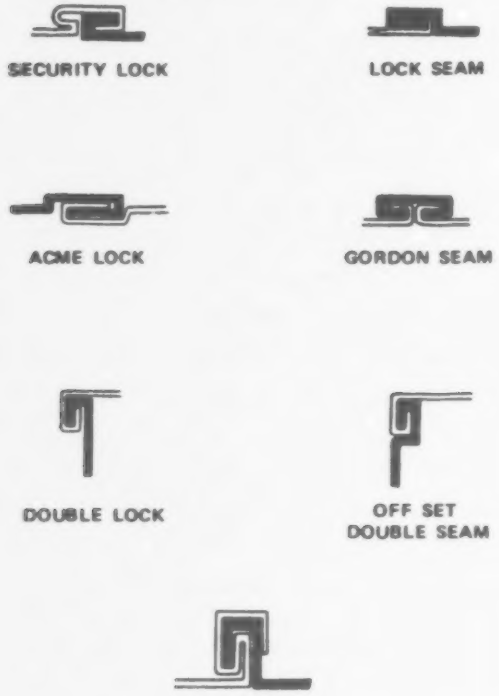

SECURITY LOCK
LOCK SEAM
ACME LOCK
GORDON SEAM
DOUBLE LOCK
OFF SET DOUBLE SEAM
FOLD LOCKED STANDING SEAM

Figure 1
Types of Lock Seams Considered Acceptable for Heating Elements

1.22 WALL FURNACE OPENINGS

1.22.1 Fan compartment and control compartment doors shall be constructed so that they will not be interchangeable when their interchange would interfere with proper operation of the appliance.

1.22.2 Openings shall be provided which will permit inspection of the heating element. These openings shall be accessible when the appliance is installed in service, and shall be of such size that smoke or reflected light may be observed inside the casing to indicate the presence or absence of leaks in the heating element resulting from a smoke bomb or light test.

1.22.3 Gaskets shall be suitable for the temperatures to which exposed.

1.23 VENT/AIR INTAKE PIPES

1.23.1 Pipe size for vent/air-intake pipes shall be determined by the manufacturer, and construction shall be in accordance with reasonable concepts of safety, substantiality and durability. Component parts shall be secured against distortion, warpage, or other damage and supported to maintain a fixed relationship between essential parts under normal and reasonable conditions of handling and usage so as to provide continued compliance with this standard.

1.23.2 The vent/air intake pipes shall be supplied as part of the direct vent system.

1.23.3 Material and gauge specifications for vent/air intake pipes shall be in accordance with section 1.20, Thickness of Materials.

1.23.4 Lock-seam joints are acceptable for the longitudinal joints in vent/air intake pipes.

1.23.5 If a telescoping slip-fit connection is used in the vent/air intake pipes to provide for installation in walls of varying thickness, the minimum overlap shall be 1¼ inches (32 mm) for horizontal vent systems, and 4 inches (102 mm) for vertical vent systems.

1.23.6 If a slip-fit connection is used at the junction of the vent pipe with the appliance, the minimum overlap shall be 1¼ inches (32 mm) for horizontal vent systems, and 4 inches (102 mm) for vertical vent systems.

1.23.7 If a slip-fit connection is used at the junction of the air-intake pipe with the appliance, the minimum overlap shall be ½ inch (12.7 mm) for horizontal vent systems and 4 inches (102 mm) for vertical vent systems.

1.23.8 Construction at the outer ends of the vent/air intake pipes shall be such as to provide a firm connection to the vent/air intake terminals and the pipes shall be fully engaged with the collar and secured with a minimum of 2 screws at opposite sides or by an equivalent mechanical means.

1.23.9 If vent kits are available with direct vent wall furnaces for use with various ranges of wall or ceiling thickness, complete information covering wall thickness and part numbers of vent kits shall be shown. The instructions shall specify the minimum overlap of the vent and combustion air tubes, when telescopic joints are used.

1.23.10 When the vent pipe is extended through a blower compartment of a downflow fan type direct vent wall furnace, the construction shall comply with section 1.21 JOINTS IN HEATING ELEMENTS and shall comply with one of the following:

a. The vent pipe shall be constructed of a corrosion-resistant material or have a corrosion-resistant finish to resist corrosion by condensate (see clause 1.2.7).

b. A sleeve shall be provided through the blower compartment, through which the vent pipe can pass when the appliance is installed. This sleeve shall be constructed of corrosion-resistant material or have a corrosion-resistant finish to resist corrosion by condensate (see clause 1.2.7).

c. The extension through the blower compartment shall provide separation of the circulating air and flue gases equivalent to that provided by the construction specified in "a" and "b" above.

One hundred percent white terry cloth test material with a pile weave on both sides, nominal 8 ounces per square yard (270 g/m²), and preconditioned at 30% relative humidity, or less, at 75°F (23.9°C) for at least 24 h, shall be used. Test samples shall consist of a single layer of the test material 6 inches (152 mm) wide, and equal in length to the height of the appliance.

A test sample shall be draped on a probe as shown in Figure 9. The appliance shall then be operated as specified in clause 2.20.1 at the end of which time the probe, with its handle maintained in a horizontal position at all times and its axis at any vertical height with respect to the appliance, advanced toward the appliance from any direction, including from above, until the frame of the probe contacts any surface or guard. The probe shall then be maintained in that position for 30 s. No flaming of the test material shall occur.

A previously unused test sample shall be used for each evaluation.

2.22 WIND TESTS

2.22.1 The gas at the pilot burner(s) shall be capable of being ignited when the vent/air intake terminal is exposed to a wind having a nominal velocity of 10 miles per hour (4.47 m/s).

Method of Test

The test shall be conducted at normal test pressure.

The appliance shall be installed in the test wall structure as specified in section 2.1. Deflector walls shall be installed against the test wall structure in order that the wind from the wind apparatus will not affect that section of the appliance normally located within the room.

A draft produced by a blower having sufficient capacity to develop a 0.04 inch w.c. (10 Pa) static pressure (nominal 10 miles per hour (4.47 m/s) wind velocity) shall be directed against the outside surface of the test structure on which the vent-air intake terminal is attached. The blower shall be located so that the wind is directed perpendicular to the surface of the wall structure. Static pressure shall be measured by means of static pressure taps encompassing the area of the vent terminal. The static pressure at these points shall indicate uniform pressure distribution. At the discretion of the testing agency, additional tests may be conducted with the same fan setting as determined above, with the draft directed from other directions.

With the appliance subjected to the above wind conditions, the gas at the pilot(s) shall be capable of being ignited.

2.22.2 The main burner(s) and pilot(s) shall not become extinguished, and the gas at the main burner(s) shall ignite from the pilot(s) without excessive delay, when the vent/air intake terminal is exposed to a wind having a nominal velocity of 40 miles per hour (17.88 m/s).

Method of Test

The test shall be conducted at normal test pressure.

The test method as specified under clause 2.21.1 shall be applied except the blower shall be capable of producing a static pressure on the surface of the test wall of 0.66 inch w.c. (164 Pa), and the pilot(s) shall be ignited before the appliance is subjected to the wind. While operating under the above wind conditions, the pilot(s) and main burner(s) when operating simultaneously, shall not become extinguished during a 10 min period.

The main burner valve shall then be shut off. After a period of at least 30 s the main burner valve shall be turned on and the main burner gas shall ignite from the pilot without excessive delay. An automatically controlled appliance shall also comply with this test when the burner(s) is turned on and off by the automatic controls.

At the discretion of the testing agency, additional tests may be conducted with the same fan setting and distance as determined above, with the draft directed from other directions.

2.23 VENT AND VENT/AIR INTAKE TERMINALS

2.23.1 A vent/air intake terminal shall be sufficiently rigid in construction and supported so that it will withstand a load of 150 lb (68.1 kg) without extensive damage or alteration of its position with respect to the appliance. Following application of this load, the appliance shall comply with the combustion test specified in the Method of Test.

Method of Test

A vertical suspension load of 150 lb (68.1 kg) shall be evenly distributed, without impact, over the vent/air intake terminal.

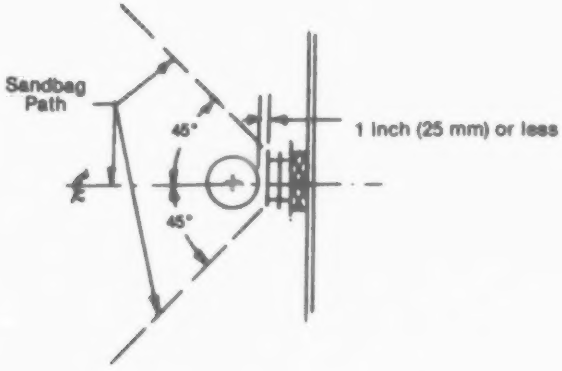
The load shall then be removed and shall not have caused substantial distortion of any part of the vent/air intake terminal or alteration of its position relative to the appliance so that the appliance would not operate satisfactorily.

The appliance shall then be operated at normal test pressure until equilibrium conditions are attained, at which time a sample of the flue gases shall then be secured and analyzed as outlined in clause 2.4.1. The concentration of carbon monoxide based on an air-free sample of the flue gases, shall not exceed 0.04%.

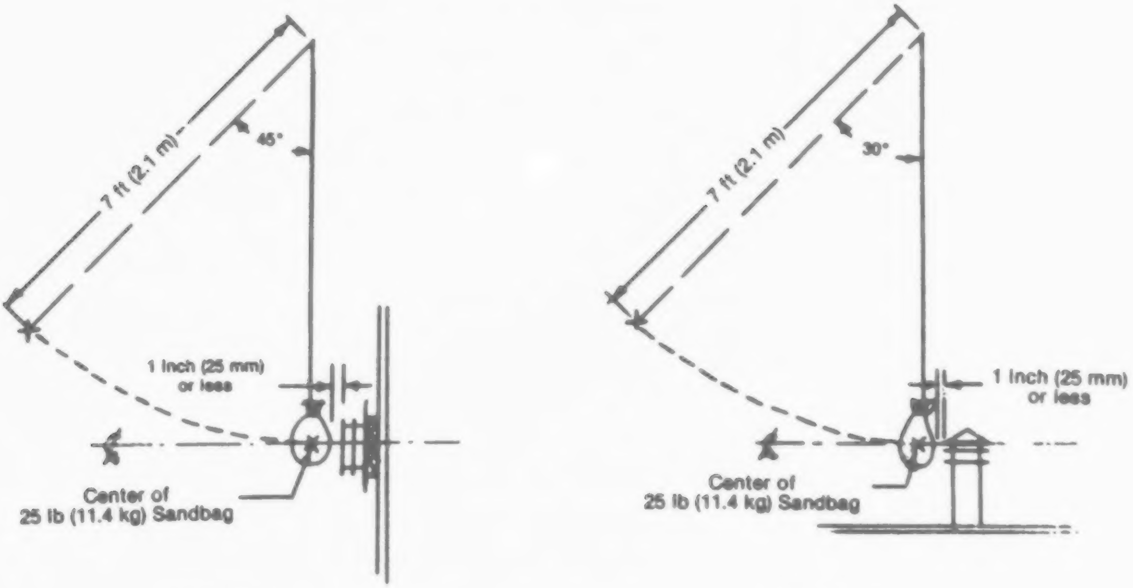
2.23.2 The vent/air intake terminal shall be sufficiently rigid in construction so as not to become damaged to the extent that it would be unsafe for use when subjected to impact in accordance with the following Method of Test. Following impact of the vent/air intake terminal, the appliance shall comply with the combustion test outlined in the Method of Test.

Method of Test

The impact shall be produced by a pendulum consisting of a cloth bag filled with sand to a weight of 25 lbs (11.3 kg) suspended from a steel cable or rope. The bag shall be formed from a flat section of burlap, canvas or suitable material. A suitable plastic liner may be used to prevent sand loss. All sides and corners of the cloth shall be drawn up as tightly as possible around the sand and the excess material tied as close as possible at the


Sandbag Path
45°
45°
1 inch (25 mm) or less

TOP VIEW


7 ft (2.1 m)
45°
1 inch (25 mm) or less
Center of 25 lb (11.4 kg) Sandbag
7 ft (2.1 m)
30°
1 inch (25 mm) or less
Center of 25 lb (11.4 kg) Sandbag

SIDE VIEW

A. HORIZONTAL CAPS

SIDE VIEW

B. VERTICAL CAPS

Figure 10

Arrangement of Standbag and Vent Terminal for Impact Test

NATIONAL STANDARD OF CANADA
CAN1-2.3-M84

GAS-FIRED GRAVITY AND FORCED AIR CENTRAL FURNACES

Effective Date — November 1985

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CAN1-2.3-M82

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PART I
CONSTRUCTION

1.1 SCOPE

1.1.1 This Standard applies to newly produced gas-fired gravity and forced air furnaces for use with propane and natural gas and to gas-fired forced air furnaces with cooling units. These furnaces are for installation in residential, commercial and industrial occupancies and in mobile housing and receational vehicles.

1.1.2 This Standard applies to central furnaces of the types defined in Part V, Definitions, hereinafter referred to as furnaces, which are designed to supply heated air through ducts to spaces remote from or adjacent to the furnace's location. Location and use of such furnaces with respect to the spaces being heated necessitates automatic operation of the appliance to provide even comfort heating and customer convenience. Accordingly, this Standard only applies to automatically operated furnaces.

1.1.3 This Standard applies to furnaces having inputs up to and including 400,000 Btuh (117.23 kW).

1.1.4 A furnace which complies with this Standard shall not be considered acceptable if it has features which impair the results contemplated by this Standard.

1.1.5 Construction and performance provisions for central furnaces are covered under Parts I and II respectively. Additional construction and performance provisions are covered in Parts III and IV respectively for central furnaces intended for use in mobile housing and recreational vehicles. Definitions are covered in Part V.

1.2 GENERAL

1.2.1 The general construction of a furnace shall be in accordance with reasonable concepts of safety, substantiality and durability, whether specifically covered by the various provisions of these construction provisions or not, based on observations made during the initial test installation as well as during all tests conducted thereafter.

All specifications as to construction set forth herein may be satisfied by the construction actually prescribed or such other construction as will provide at least equivalent performance.

1.2.2 A furnace shall be of such construction that no part of the products of combustion will become mixed with the circulating air.

1.2.3 The base of a furnace shall be constructed to provide for the adequate support of the furnace and shall be substantially constructed of metal or fabricated from other non-combustible material in a manner to provide equivalent strength and durability. A sub-base, if furnised as a separate assembly shall be arranged in a manner that will establish and maintain correctly the position of the furnace with respect to the sub-base.

1.2.4 The base and sub-base of a downflow furnace intended for installation on combustible flooring shall be designed to establish and maintain not less than the required clearance between vertical surfaces of the plenum or duct to be attached thereto and the floor construction and shall be designed so that a non-combustible fire stop results from the installation.

1.2.5 Insulating materials shall be mechanically or adhesively retained in place. Insulating materials and their internal bonding or adhesive attachment means shall withstand temperatures and air velocities to which subjected in operation without displacement or damage. If the insulation is such that air impingement on edges might cause displacement or damage, such edges shall be protected.

1.2.6 Combination units in which a refrigeration coil is provided shall have the refrigeration coil located downstream from the heating section, unless that heating section is specifically tested for installation downstream from the coil (see 1.30 (FORCED AIR FURNACES DESIGNED FOR INSTALLATION DOWNSTREAM FROM REFRIGERATION SYSTEMS), 2.28 (ibid), and 2.29 (COOLING SECTION OF FORCED AIR FURNACES WITH COOLING UNITS)) or the coil shall be located parallel to the heating section. In those cases where the coil is located parallel to the heating section, dampers or other means used to control flow of air shall be adequate to prevent chilled air from entering the furnace section. If the dampers are manually operated, means shall be provided to prevent operation of either unit unless the damper is in the full heat or cool position. Adequate means shall be provided for disposal of condensate and to prevent dripping of condensate on the heating element.

1.2.7 A direct vent system furnace shall be provided with the vent-air intake system as part of the furnace. Vent-air intake systems shall be provided with means for secure attachment to the furnace.

1.2.8 A furnace designed for outdoor installation shall also comply with the current standard CAN1-2.21 GAS-FIRED APPLIANCES FOR OUTDOOR INSTALLATION.

1.2.9 A furnace equipped with an automatic vent damper device shall comply with the applicable construction provisions of the current Standard CAN1-2.28 GAS-FIRED APPLIANCES EQUIPPED WITH ELECTRICALLY OPERATED AUTOMATIC VENT DAMPER DEVICES PROVIDED AS INTEGRAL COMPONENTS.

1.2.10 Enclosed furnaces shall, in addition to the other provisions included under Part I of the Standard, comply with the provision of 1.29 ENCLOSED FURNACE ENCLOSURE.

1.2.11 Furnaces designed for installation in mobile housing or recreational vehicles shall comply with the additional provisions specified in Part III.

1.3 ASSEMBLY

1.3.1 All parts that may come in contact with the operator's hand during normal adjustment or servicing shall be free from sharp projections or edges and projecting screw ends.

1.3.2 Tap bolts used to attach any part which must be adjusted or removed for servicing shall be of corrosion resistant material or have a corrosion resistant coating.

1.3.3 Bolts, nuts, screws, except sheet-metal screws, and other threaded parts used in the general assembly of the appliance shall have threads conforming to the current CSA Standard B1.1 UNIFIED AMERICAN SCREW THREADS and current ANSI Standard B1.5 ACME SCREW THREADS.

1.3.4 All parts shall be of such construction as to be secure against displacement, distortion, warping or other damage from normal usage and the effects of transportation before and after installation.

1.3.5 Fastening means, used for securing parts that may need servicing, shall be of a reusable type.

1.4 ACCESSIBILITY

1.4.1 All clauses concerning accessibility and visual checks shall be performed with the furnace installed as it would be in service in accordance with the manufacturer's instructions at the specified minimum service clearances.

1.4.2 All controls shall be accessible for normal servicing and functional adjustment in position, and shall be replaceable during normal servicing. Manifold assemblies which permit removal of control(s) intact shall be considered to meet this provision for servicing. Removal of an access panel or door to provide access to a control compartment shall be considered acceptable.

1.4.3 When bolts or screws must be removed to permit removal of cleanout plates, the heads and nuts of bolts and the threads of screws shall be placed where they will not be in contact with flue gases.

1.4.4 Removable flue baffles shall be constructed such that the baffle cannot be installed in the appliance in other than the correct position.

1.4.5 When the removal of the jacket is necessary for cleaning the flueways of furnaces having a rated input of less than 250,000 Btuh (73.3 kW), the jacket and insulation shall be designed and constructed so that they may be assembled and disassembled by one man in reasonable time.

1.4.6 Access panels and such insulation as need be removed for normal service and accessibility shall be designed so that repeated removal and replacement will not cause damage or impair insulating value.

1.4.7 The flue gas passageways through furnaces shall be accessible for cleaning.

1.4.8 Provision shall be made to permit removal and replacement of the filters and oiling the motor and blower bearings without dismantling or removing any portion of the draft hood or vent connector. For removal of the blower assembly, it is permissible to disconnect the draft hood or vent connector.

1.4.9 Any access door or panel which is exposed to weathering shall require the use of a tool to open.

1.5 COMBUSTION AIR AND VENTILATION

1.5.1 When a separate automatic combustion air door is provided, the construction and appliation shall be such that the force of gravity will open the air door in case the control becomes inoperative.

When the automatic air door is directly connected to an automatic valve, the air door shall not be required to open should the automatic valve fail to open.

The air door shall open upon manual operation of the automatic valve, or in the event the operating linkage fails. Manipulation of the air door shall not cause the automatic valve to open.

1.5.2 Cabinet compartments housing gas piping and controls shall be adequately ventilated.

1.5.3 Combustion air for burner and pilot operation shall not be drawn from the circulating air stream.

1.5.4 The top or plane of any concealed combustion air or ventilation opening(s) shall not be less than 2 inches (51 mm) above the floor level. The bottom of such openings shall not be less than 1 inch (25.4 mm) above the floor level unless all performance requirements can be met with the bottom of the opening blocked to a distance of 1 inch (25.4 mm) above the floor.

1.5.5 The construction of the furnace shall be such that when installed in accordance with the manufacturer's instructions, the combustion air supply shall be in the same pressure zone as the draft hood relief opening on appliances equipped with draft hoods.

1.5.6 Openings in perforated or expanded metal panels, provided over combustion air, circulating air or draft hood relief openings, shall not be less than 1/8 inch (3.18 mm) diameter. If the openings in such panels are other than circular in shape they shall be of such size that will permit entrance of a 0.161 inch (4.1 mm) diameter rod.

1.5.7 The construction of a direct vent system furnace shall be such that when installed in accordance with the manufacturer's instructions, the combustion air supply, under static conditions, will be in the same pressure zone as the vent outlet (refer to 1.2.7 (GENERAL)).

1.5.8 Combustion air supply openings, with the exception of primary air shutters, shall not be adjustable. Mechanical means may be provided for adjustment combustion air supply to burners other than the atmospheric type.

1.5.9 On a furnace provided with an induced draft or power burner, the design shall be such as to prevent gas flow to the main burner(s), or to the main burner(s) and pilot burner(s) when an interrupted or intermittent pilot ignition system(s) is used, in the event the blower providing the draft becomes inoperative. A properly applied centrifugal or sail switch, or equivalent device, meets the intent of this provision. If a centrifugal switch is used, the blower shall be secured to the shaft on which the centrifugal switch is located, by keying, or by at least two screws, one of which shall be on a flattened shaft, or the equivalent.

1.6 MAIN BURNERS

1.6.1 Bodies of burners (including mixer head, mixer tube and burner head) shall be of substantial and durable construction. They shall be made of metals having a melting point above 1450°F (788°C).

1.6.2 Burners ports shall be machined or otherwise accurately made.

1.6.3 Ports shall be clear and free of burrs inside the burner.

1.6.4 Iron or steel pipe or tubing, when tapped or threaded and used in the construction of a burner, shall comply with the current CSA Standard B63 WELDED AND SEAMLESS STEEL PIPE.

1.6.5 Joints, when used in the pressure zone or in the burner head of a burner assembly shall be gastight and shall not depend for mechanical strength nor primarily for tightness on cement or other sealing material, except where such joints form part of the port area. Joints shall be securely bolted, screwed, machined, welded, brazed or of equivalent construction.

1.6.6 Bolt holes shall not intersect gasways unless adequate provision is made to assure gastightness.

1.6.7 Gauzes shall not be used in the burner construction.

1.6.8 The construction shall be such that the burner cannot be installed in the appliance in other than the correct position.

1.6.9 Burner parts requiring field assembly shall be constructed so that they cannot be incorrectly fitted together within the appliance, or they shall bear a Class I marking indicating the correct method of assembly.

1.6.10 Sheet-metal burner parts shall be at least 0.0304‡ inch (0.773 mm) thick AISI C1010 steel or of metal of equivalent or superior strength and durability.

1.6.11 Ribbon burners shall be constructed so that the ribbon assembly can be easily removed, cleaned and replaced in the field without the use of special tools.

1.6.12 Main burners and mixer tubes shall be properly placed and securely positioned without the use of set screws in the heat zone, so they will not twist, slide or drop out of position. They shall not be attached to their supports by means of bolts, cotter pins or screws within the burner compartment. Restrictions as to the method of fastening need not apply to mixer tubes of single port burners or to temporary fastenings for shipping. The construction shall be such that the burner cannot be installed in the appliance in other than the correct position.

1.6.13 Burner and mixer tubes shall be removable through an access opening or door, without disconnecting, dismantling, or removing the pilot burner assembly, controls, burner manifold or any parts other than the access door. Pilot burner and main burner, or manifolds, or both which are easily removed as a unit, and mixer tubes of single port burners, are exempt from this provision.

1.6.14 If a burner tray is used the means for fastening shall be readily accessible and shall be designed so that one man can perform the removal and replacement unassisted.

1.6.15 When carry-over flames are necessary to accomplish satisfactory ignition between adjacent rows of ports or adjacent burners, carry-over shall be effected by more than one series of ports or by other means which have been demonstrated to be satisfactory in the field.

1.6.16 Provisions shall be made to permit satisfactory observation of main burner and pilot flames during adjustment.

1.6.17 Flame observation ports of direct vent central furnaces shall be constructed of heat-resistant material and, unless located within the cabinet casing, shall be protected from mechanical damage. Glass, if used, shall be framed and of not less than 1/8 inch (3.18 mm) thickness.

1.6.18 If a factory installed conversion burner is used on a furnace, the conversion burner rating plate shall not be used. This will avoid any implication after installation that the furnace has been field converted.

1.7 PRIMARY AIR CONTROL

1.7.1 Primary air control means shall be designed so that the flow of primary air can be controlled to provide proper flame characteristics.

1.7.2 Primary air adjustment means, when provided, shall not change position by the action of gravity when the means for locking the adjustment is loosened sufficiently to permit adjustment.

1.26 VENT AND AIR INTAKE PIPES OF DIRECT VENT SYSTEMS

1.26.1 Pipe size for vent and air-intake pipes shall be determined by the manufacturer, and construction shall be in accordance with reasonable concepts of safety, substantiality and durability. Component parts shall be secured against distortion, warpage, or other damage and supported to maintain a fixed relationship between essential parts under normal and reasonable condtions of handing and usage so as to continue to comply with this Standard.

1.26.2 The design and specifications of a direct vent system shall be such that the air-intake and vent pipes are supplied as parts of the furnace.

1.26.3 Specifications for materials used in the construction of vent and air-intake pipes shall be in accordance with 1.19, (THICKNESS OF MATERIAL).

1.26.4 Lock-seamed joints are acceptable for the longitudinal joints in air-intake and vent pipes, except as prohibited in 1.20.2, (JOINTS IN HEATING ELEMENTS).

1.26.5 If a telescoping slip-fit connection is used in the air intake and vent tubes to provide for installation in walls or ceiling of varying thickness, the minimum overlap shall be 1 1/4 inches (32 mm) for horizontal vent systems and 4 inches (102 mm) for vertical vent systems.

1.26.6 If a slip-fit connection is used at the junction of the vent tube with the unit, the minimum overlap shall be 1 1/4 inches (32 mm).

1.26.7 If a slip-fit connection is used at the junction of the air-intake tube and the unit, the minimum overlap shall be 1/2 inch (12.7 mm).

1.26.8 Construction of the outer ends of the air-intake and vent tubes shall be such as to provide a firm connection and the tubes shall be fully engaged with the collar and secured with two screws at opposite sides or secured by an equivalent mechanical means.

1.27 AIR FILTERS

1.27.1 Circulating-air filters, when provided, shall comply with the current Standard ULC S111 METHOD OF FIRE TESTS FOR AIR FILTER UNITS.

1.27.2 Filters, when provided, shall be accessible through a service panel for inspection and replacement by the user without the use of special tools.

1.27.3 When applicable, instructions for replacing filters shall be provided on the filter service panel, or reasonably adjacent thereto, by a Class V marking. These instructions shall specify that the filter be replaced by the same dimensional size as is given on the filter itself and specify that the replacement filter must be certified (ULC or equivalent). All the above instructions shall appear in a form which can be easily understood in both the English and French languages.

1.27.4 Gravity type furnaces, with or without integral or booster fans, shall not use filters, and notice to this effect shall be incorporated in the manufacturer's installation instructions.

1.28 WATER CONNECTIONS

Aluminum tubing shall not be used for water connections.

1.29 ENCLOSED FURNACE ENCLOSURE

1.29.1 The enclosure of an enclosed furnace shall be fabricated from sheet metal having a thickness not less than 0.0304‡ inch (0.772 mm), or material of at least equivalent rigidity and strength.

1.29.2 The area of an enclosure of an enclosed furnace which is exposed to outside air on one side of air in the heated space on the other side shall be insulated with material having a conductance not greater than 0.54 Btuh/ft^2/°F (3.066 W/m^{2}K). The insulation shall be of a fire-resistive type such as fibre glass.

1.29.3 Joints which could permit leakage of combustion products into the heated area shall be sealed to prevent leakage. Gaskets or equivalent means shall be used at such joints.

1.29.4 Means shall be provided to prevent the accumulation of water in the enclosure. Water shall not interfere with combustion or contact any electrical equipment.

1.29.5 Exterior grills of an enclosed furnace shall be constructed of corrosion-resistant material or have corrosion-resistant finish.

1.30 FORCED AIR FURNACES DESIGNED FOR INSTALLATION DOWNSTREAM FROM REFRIGERATION SYSTEMS

1.30.1 The heating element(s), burner(s), and burner enclosure(s) shall be constructed of a corrosion-resistant material, or have a corrosion-resistant finish to resist corrosion by condensate. The jacket shall be constructed of a corrosion-resistant material or have a corrosion-resistant finish to resist corrosion by condensate, or shall be protected from condensate, or shall be protected from condensate by insulation having a conductance not greater than 0.54 Btuh/ft^2/°F (3.066 W/m^{2}K). The insulation shall be of fire-resistive type such as fibre glass. Stainless steel, ceramic-coated steel, or an aluminum-coated steel in which the bond between the steel and the aluminum is an iron aluminum alloy are considered to be corrosion resistant.

1.30.2 *The electrical equipment and wiring shall be* suitably protected from condensate.

1.30.3 Adequate means shall be provided for the collection and disposal of condensate.

where:

R_t = test rate

P = actual barometric pressure (inches H_g)

R_s = manufacturer's specified input rate

2.3.6 The minimum input rating for test purposes, on appliances provided with controls which will reduce the input rating by automatic means, shall be 87% of the minimum input rating, specified by the manufacturer. The manufacturer's specified minimum input rating shall not be less than 20% of the manufacturer's specified normal input rating.

2.4 COMBUSTION

2.4.1 A central furnace shall produce negligable carbon monoxide. This provision shall be deemed met when a concentration not in excess of 0.04% is present in an air-free sample of the flue gases when the furnace is tested in an atmosphere having approximately a normal oxygen supply.

METHOD OF TEST

Gravity type central furnaces, as defined in Part V, shall be equipped with warm air outlet duct work as specified in 2.14.2, (OUTPUT CAPACITY AND FLUE AND CASING LOSES).

Forced air type central furnaces, as defined in Section V, shall be equipped with a duct, as specified in 2.1.7, (TEST DUCTS AND PLENUMS) the outlet end of which shall be symmetrically restricted until the furnace is operating against an external static pressure as specified in 2.1.8, (STATIC PRESSURES). Under the conditions of holding static pressure constant the normal temperature rise can be allowed to vary slightly.

Burner and primary air adjustments shall be made in accordance with the provisions of 2.3.5, (TEST PRESSURES AND BURNER ADJUSTMENTS).

After adjustment and with all parts of the furnace at room temperature, the pilot(s) shall be placed in operation and allowed to operate for a period of 5 min at which time the main burner(s) shall be placed in operation. The furnace shall then be operated for 3 min at normal test pressure at which time a sample of the flue gases shall be secured. Immediately upon securing the sample at normal test pressure, the reduced test pressure (see 2.3.1, (TEST PRESSURES AND BURNER ADJUSTMENTS)) shall be applied, and following a purge period of at least 2 min another sample of the flue gases,shall be secured. The appliance pressure regulator shall then be adjusted to provide an increase in the input rate specified by the manufacturer of 12 percent for furnaces for use with natural gas and 9 percent for furnaces for use with propane. When the regulator outlet pressure cannot be readily adjusted to obtain this increase in input rate, the regulator may be removed or blocked in the open position, or the inlet test pressure may be increased as necessary.

The appliance shall then be allowed to continue in operation for 15 min from the time it was initially placed in operation, at which time another sample of the flue gases shall be secured.

On central furnaces not provided with an appliance pressure regulator for use with propane, the increased input rate (see 2.3.3, (TEST PRESSURES AND BURNER ADJUSTMENTS)) shall be applied and the furnace allowed to continue in operation for 15 min from the time it was initially placed in operation at which time another sample of the flue gases shall be secured.

On furnaces provided with a power burner or induced draft, an additional combustion sample shall be secured with the appliance operating at normal test pressure and the supply voltage reduced 85% of the appliance rating plate voltage as specified in 2.1.15, (TEST VOLTAGES).
Samples shall be secured between the furnace and draft hood and vent terminal at a point where uniform samples can be obtained. When this method of sampling is not practical, the procedure shall be left to the discretion of the testing agency. The flue gas samples shall be analyzed for carbon dioxide and carbon monoxide.

2.4.2 Central furnaces for use with natural gas shall comply with the provisions of 2.4.1, (COMBUSTION) when adjusted and operated with natural gas at 4.0 inches w.c. (1.0 kPa) pressure.

METHOD OF TEST

This test need not be applied when the manifold pressure at the 4.0 inches w.c. (1.0 kPa) pressure adjusted is not lower than that specified by the manufacturer for natural gas.

The gas rate shall be adjusted at 4.0 inches w.c. (1.0 kPa) test pressure with natural gas to the test rate, R_t, (see 2.3.4, (TEST PRESSURES AND BURNER ADJUSTMENTS)) upon 15 min of operation, starting with all parts of the furnace at room temperature. Primary air shall be set to give a good flame at this adjustment. After adjustment and with all parts of the furnace at room temperature, the pilot(s) shall be placed in operation and allowed to operate for a period of 5 min, at which time the main burner(s) shall be placed in operation. The furnace shall then be placed in operation. The furnace shall then be operated for 3 min at which time a sample of the flue gases shall be secured and analyzed in the manner prescribed by 2.4.1, (COMBUSTION).

2.4.3 The combustion characteristics of a gravity type furnace, as indicated by the carbon dioxide content in the flue gases, shall not be affected when it is operated under the following conditions:

a. operating when rated and adjusted as specified under 2.4.1 with duct work as specified under 2.14.2 with the control chamber panel closed, and

b. same as "a" except with the control chamber panel open.

chimney stoppage. This provision shall be deemed met when the appliance complies with the following specific conditions. Furnaces designed for outdoor installation with the venting system provided as a part of the unit and direct vent central furnaces shall be exempt from the provisions of this section.

2.24.1 BLOCKED OUTLET. With the flue outlet blocked to any degree up to and including complete closure, the concentration of carbon monoxide in an air-free sample of the flue gases shall not exceed 0.04% when the appliance is tested in an atmosphere having a normal oxygen supply. Should outage occur, raw gas shall not be forced into the combustion chamber on reopening the flue outlet.

METHOD OF TEST

This furnace shall be operated for at least 15 min at normal test pressure. Burners shall be adjusted as specified in 2.3.5, (TEST PRESSURES AND BURNER ADJUSTMENTS). The outlet of the furnace shall be blocked and a sample of the products of combustion secured and anlyzed as specified in 2.4.1, (COMBUSTION). When the furnace incorporates a control to automatically shut off the main gas supply under blocked flue conditions, the area of the flue outlet shall be gradually decreased to the lowest point at which the control will remain in its open position.

In case of outage, the blocked conditions shall be maintained for 3 min to allow for operation of safety devices, and then removed and observation made.

2.24.2 UPDRAFT. A chimney action, consisting of a static updraft and velocity updraft numerically totalling between 0.06 and 0.07 inch w.c. (15 and 17 Pa) applied to the flue outlet of the furnace shall not cause a fractional increase in the volume of flue gases greater than twice the numerical sum of the pressure head and five times the velocity head expressed as inches w.c.

METHOD OF TEST

The Method of Test outlined under clause 2.23.4, (DRAFT HOODS) shall apply except that the straight length of flue pipe shall be attached directly to the flue outlet and the updraft shall be imposed at the flue outlet of the furnace.

2.25 DIRECT VENT CENTRAL FURNACES

The provisions outlined under this section are applicable only to direct vent central furnaces.

2.25.1 WIND TESTS — PILOT IGNITION. The pilot(s) shall be capable of being ignited when the vent-air intake terminal is exposed to a wind of sufficient velocity to produce a static pressure at the wall surface of 0.04 inch w.c. (10 Pa) (nominal 10 mph (4.5 m/s) wind velocity), at a wind angle perpendicular to the surface of the wall structure. At the discretion of the testing agency, additional tests may be conducted with the same fan setting and distance as determined above, with the draft directed from other directions.

METHOD OF TEST

The test shall be conducted at normal test pressure.

The appliance shall be installed in the test wall structure as specified in 2.1.10, (TEST INSTALLATION) and 2.1.12, (INSTALLATION — RECREATIONAL VEHICLES AND MOBILE HOUSING). Deflector walls shall be installed against the test wall structure in order that the wind from the wind apparatus will not affect that section of the appliance normally located within the room.

A draft produced by a blower having sufficient capacity to develop a 0.04 inch w.c. (10 Pa) static pressure (nominal 10 mph (4.5 m/s) wind velocity) shall be directed against the outside surface of the test structure on which the vent-air intake terminal is attached. The blower shall be located so that the wind is directed perpendicular to the surface of the wall structure. Static pressure shall be measured by means of static pressure taps encompassing the area of the vent terminal.

The static pressures at these points shall indicate uniform pressure distribution. At the discretion of the testing agency, additional tests may be conducted with the same fan setting as determined above, with the draft directed from other directions.

With the appliance subjected to the above wind conditions, the pilot(s) shall be capable of being ignited.

2.25.2 WIND TESTS. The main burner(s) and pilot(s) shall not become extinguished, and the main burner(s) shall ignite from the pilot without excessive delay, when the vent-air intake terminal is exposed to a wind of sufficient velocity to produce a static pressure at the wall surface of 0.66 inch w.c. (164 Pa) (nominal 40 m/h (17.9 m/s) wind velocity), at a wind angle perpendicular to the surface of the wall structure.

At the discretion of the testing agency, additional tests may be conducted with the same fan setting and distance as determined above, with the draft directed from other directions.

METHOD OF TEST

The test shall be conducted at normal test pressure.

The test method as specified in 2.25.1, (DIRECT VENT CENTRAL FURNACES) shall be applied except the blower shall be capable of producing a static pressure on the surface of the test wall of 0.66 inch w.c. (164 Pa), and the pilot(s) shall be ignited before the appliance is subjected to the draft. While operating under the above wind conditions, the pilot(s) when operating alone, and the pilot(s) and main burner(s) when operating simultaneously, shall not become extinguished during a 10 min period.

The main burner valve shall then be shut off. After a period of at least 30 s the main burner valves shall be turned on and the main burner gas shall ignite from the pilot flame without excessive delay. The appliance shall also comply with this test when the burner(s) are turned on and off by the automatic controls.

At the discretion of the testing agency, additional tests may be conducted with the same fan setting and distance as determined above, with the draft directed from other directions.

2.25.3 INTAKE INTEGRITY LOAD TEST. The vent-air intake terminal shall be sufficiently rigid in construction and support so that it shall resist, without extensive damage, and without alteration of its position with respect to the appliance, a load equivalent to 150 lb (68 kg force). The unit shall comply with the provisions of 2.4.1, (COMBUSTION) at normal test pressure.

METHOD OF TEST

A vertical suspension load equal to 150 lb (68 kg force) shall be applied, without impact, evenly distributed over the vent-air intake terminal.

The load shall be removed and the appliance placed in operation at normal test pressure and operated until equilibrium conditions are reached. The system shall be observed and shall comply with the provisions of 2.4.1, (COMBUSTION) at normal test pressure.

The load shall not cause substantial distortion of any part of the vent-air intake terminal or alteration of its position relative to the furnace so that the appliance will not operate satisfactorily.

2.25.4 INTAKE INTEGRITY IMPACT TEST. The vent-air intake terminal shall be rigid in construction so that it will not become damaged sufficiently to cause it to be unsafe for use, when subjected to impact in accordance with the Method of Test. The furnace shall comply with the provisions of 2.4.1, (COMBUSTION) at normal test pressure.

METHOD OF TEST

The impact shall be produced by a pendulum consisting of a cloth bag filled with sand to a weight of 25 lb (11.3 kg), suspended from a steel cable or rope. The bag shall be formed from a flat section of burlap, canvas or suitable material. A suitable plastic liner may be used to prevent sand loss. All sides and corners of the cloth shall be drawn up as tightly as possible around the sand and the excess material tied as close as possible at the top of the bag. The bag shall have an at-rest position not more than 1 inch (25.4 mm) measured from the edge of the bag to the nearest edge of the vent-air intake terminal. The point of impact shall be opposite the center of gravity of the bag. The distance of swing (angle 45 degrees) shall be measured as the angle between the pendulum arm with the bag at its at-rest position and the pendulum arm at its elevated position. The length of the pendulum is that distance measured from the point of rotation to the center of gravity of the bag.

One impact shall be made at each of the following points, as shown in Figure 10.

a. the center of the vertical front surface of the vent-air intake terminal

b. leading edge of the left side of the vent-air intake terminal, pendulum rotated left, at an angle 45 degrees from point "a"

c. leading edge on the right side of the vent-air intake terminal pendulum rotated right, at an angle 45 degrees from point "a"

Following each impact, the appliance shall be placed in operation at normal test pressure and operated until equilibrium conditions are reached. The system shall be observed and shall comply with 2.4.1, (COMBUSTION) at normal test pressure.

At the option of the manufacturer, the vent-air intake terminal may be replaced following each impact and combustion test.

2.25.5 TIGHTNESS OF JOINTS. Joints in direct vent systems shall be tight. This provision shall be deemed met if leakage from the system is not in excess of the limits specified in the following Method of Test.

METHOD OF TEST

The vent-air intake terminal(s) shall be removed and the entrance of the air intake system at the point it enters the combustion chamber sealed. The entire system, including the combustion air and flue gas connections between the appliance and the vent-air intake terminal(s), shall be installed and sealed in accordance with the manufacturer's instructions.

Both the flue outlet and the air inlet shall then be sealed at the point of connection to the vent-air terminal(s). The sealing means shall include fittings for supplying to both the air inlet and combustion chamber sides of the system and provisions for measuring the internal pressure in each side of the system.

The internal system pressure shall be determined by connecting the means for determining internal pressure for a water-filled manometer which may be read directly to 0.01 inch w.c. (2 Pa).

A suitable supply of clean air shall be permitted to flow through a wet test meter and into the portion of the direct vent system being pressurized through the air supply fitting. The air supply fitting to the portion of the system not being pressurized shall be open.

The meter pressure shall be adjusted to produce an internal air pressure of 0.1 inch w.c. (2.5 Pa) above the normal operating system pressure (atmosphere for other than forced or induced draft systems) in the portion of the system being pressurized and the leakage rate noted for both the air inlet and combustion chamber portions of the direct vent system.

Compliance with this provision shall be deemed met if leakage from the combustion chamber portion of the system does not exceed 2.0% of the products of combustion and leakage from the air inlet portion of the system does not exceed 8.0% of the products of combustion. These values shall be determined by the following appropriate formulae*:

$$L_{cf} = .02 \times V_f \times I_B$$

$$L_{af} = .08 \times V_f \times I_B$$

where:

L_{cf} = allowable leakage rate from combustion chamber section of the direct vent system, ft^3/h.

L_{af} = allowable leakage rate from air inlet section of direct vent system, ft^3/h.

V_f = 15 ft^3 (0.42 m^3) of flue products based on the formation of approximately 10 ft^3 (0.28 m^3) of dry flue products, plus 5 ft^3 (0.14 m^3) of excess air, when 1000 Btu of fuel gas is burned.

I_B = appliance input rate, in thousands of Btuh.

or

$$L_{cm} = .02 \times V_m \times I_w$$

$$L_{am} = .08 \times V_m \times I_w$$

where:

L_{cm} = allowable leakage rate from combustion chamber section of the direct vent system, m^3/h.

L_{am} = allowable leakage rate from air inlet section of direct vent sysem, m^3/h.

V_m = 0.09656 m^3 of flue products based on formation of approximately 0.06437 m^3 of dry flue products, plus 0.03219 m^3 of excess air, when 3.6 MJ of fuel gas is burned.

I_w = appliance input rate, kW.

* *These formulae may be simplified to read*

$L_{cf} = 0.3\ I_B$ and $L_{af} = 1.2\ I_B$

$L_{cm} = 0.00193\ I_w$ and $L_{am} = 0.00772\ I_w$

2.26 ENCLOSED FURNACES

2.26.1 WIND TESTS. The furnace shall comply with the provisions of 2.4.1, (COMBUSTION) (sample to be taken at the end of 15 min of appliance operation at normal input rating), 2.5, (BURNER OPERATING CHARACTERISTICS) and 2.7, (PILOT BURNERS AND SAFETY SHUT-OFF DEVICES) under the following conditions of test with the appliance operating at normal test pressure.

METHOD OF TEST

A draft produced by a blower having sufficient capacity to develop a 15 mph (6.7 m/s) wind shall be directed against the outside surface of the test wall through which the combustion and ventilation air grill(s) extend. The blower shall be located so that the draft is directed perpendicular to the face of the grill(s) and has a horizontal velocity of 15 mph (6.7 m/s) at a point 18 inches (457 mm) from the surface of the test wall. The draft established shall be such that it totally encompasses the area of the grill(s). At the discretion of the testing agency, additional tests may be conducted with the draft directed from some other direction. Conditions of each test specified shall be established prior to application of the 15 mph (6.7 m/s) wind.

2.26.2 Under the following conditions of test (a) neither the main burner nor the pilot shall become extinguished, (b) the main burner shall ignite from the pilot and, (c) it shall be possible to manually or automatically ignite the pilot.

METHOD OF TEST

This test shall be conducted at normal test pressure.

A draft produced by a blower having sufficient capacity to develop a 40 mph (17.9 m/s) wind shall be directed against the outside surface of the test wall through which the combustion and ventilation air grill(s) extend. The blower shall be located so that the draft is directed perpendicular to the face of the grill(s) and has a horizontal velocity of 40 mph (17.9 m/s) at a point 18 inches (457 mm) from the surface of the test wall. The draft established shall be such that it totally encompasses the area of the grill(s). At the discretion of the testing agency, additional tests may be conducted with the draft directed from some other direction.

With the appliance operating under the above wind conditions neither the main burner nor pilot burner flames shall become extinguished during 15 min period of operation.

The main burner valve shall then be shut off. After a period of 30 s, the main burner gas shall ignite from the pilot flame.

With both the main and pilot burners off and the appliance subjected to the wind conditions specified above, it shall be possible to manually or automatically ignite the pilot.

2.26.3 Horizontal surfaces of enclosure of enclosed furnaces shall not be permanently deformed in excess of 1/4 inch (6.35 mm) when subjected to the following Method of Test.

METHOD OF TEST

A circular block having a diameter of 6 inches (152 mm) shall be placed at a point on the horizontal surface where a load will cause maximum deformation. A dial indicator having scale graduations of 0.001 inch (0.025 mm) shall be placed under the enclosure surface directly below the center of the block and an initial reading shall be taken. A load of 200 lb (90.7 kg) shall then be placed without impact upon the block. After 5 min have elapsed the load shall be removed. The dial indicator shall be read again and the permanent deformation indicator shall not exceed 1/4 inch (6.35 mm).

2.27 MOTOR RATING — AIR CIRCULATING BLOWERS AND FANS

The brake load and the ambient temperature imposed on the motor driving an air circulating blower or fan shall be determined in accordance with, and shall not exceed the requirements of the current CSA Standard C22.2, No. 3, ELECTRICAL FEATURES OF FUEL-BURNING EQUIPMENT, except that the external static pressure specified in 2.1.8, (STATIC PRESSURES) shall be used during the test.

PART III
ADDITIONAL CONSTRUCTION FOR FURNACES USED IN MOBILE HOUSING AND RECREATIONAL VEHICLES

3.1 GENERAL

3.1.1 For furnaces designed to be installed in mobile housing or recreational vehicles, the clauses of Part III shall apply in addition to those in Part I.

3.1.2 Furnaces intended for installation in recreational vehicles shall be equipped to operate on propane only or shall be readily convertible to operate on propane or natural gas. (See 3.7, (CONVERTIBILITY)).

3.1.3 Furnaces intended for installation in mobile housing shall be equipped to operate on either propane or natural gas and shall be readily convertible. (See 3.7, (CONVERTIBILITY).

3.1.4 Furnaces shall be of a construction providing complete separation of the combustion system from the atmosphere within the living space of the vehicle.

3.1.5 All components required to convey the flue gases to the outdoors and to convey combustion air from the outdoors shall be provided with each furnace.

3.1.6 Any access door or panel exposed to the weather shall require the use of a tool to open.

3.1.7 Any access door, or flame observation port or panel providing separation of the combustion system from the living space shall be so constructed that the separation is maintained after repeated replacement, after removal, without the use of single use sealants.

3.1.8 A furnace intended for floor mounting shall be provided with facilities at the front and rear to permit secure and ready attachment to the floor structure of the mobile housing or recreational vehicle to prevent separation from the base or floor at any point.

3.1.9 A furnace intended to be supported entirely by the wall or ceiling shall be provided with facilities to permit secure and ready attachment to either the wall or the ceiling.

3.1.10 Any components exposed to the weather shall be provided with means for mechanical attachment to the vehicle.

3.2 ACCESSIBILITY

3.2.1 The flue gas passageways shall be accessible for cleaning.

3.2.2 Furnaces designed for installation in mobile housing or recreational vehicles need not comply with the accessibility for servicing and lighting provisions of 1.4 when the manufacturer's installation instructions specify use of an exterior access opening in the mobile home or recreational vehicle adequate for servicing and lighting.

3.3 COMBUSTION AIR INTAKES AND VENTS

A combustion air intake assembly or flue gas vent

a. to be installed through an outside wall of a recreational vehicle shall not project beyond the outside wall more than 1 inch (25 mm).

b. to be installed through the roof of a recreational vehicle shall terminate with the lowest point of the opening at least 6 inches (152 mm) and 10 inches (254 mm) above the highest point of contact with the roof, respectively unless the furnace is other than the direct vent type in which case it shall comply with 4.2, (BLOCKED AIR INLET OR FLUE GAS VENT OUTLET TESTS).

c. to be installed through the roof of mobile housing shall have the flue gas outlet and combustion air intake so designed that they can be readily added to or extended to attain a minimum height of 24 inches (610 mm) to the bottom of the flue gas vent outlet and at least 20 inches (508 mm) to the combustion air intake opening. In no case shall the dimensions between the openings be less than 4 inches (102 mm). This does not apply to openings intended to provide cooling air to the roof jack.

3.4 BURNERS

3.4.1 Burners of furnaces convertible for use with propane or natural gas shall be designed to operate satisfactorily with both gases.

3.4.2 Burners shall be fastened in place and arranged so that they may be readily removed for servicing.

3.5 ORIFICES

Furnaces convertible for use with propane or natural gas shall be supplied with properly identified orifices for both propane and natural gas. One set of orifices shall be in place in the main and pilot burners when an appliance is shipped from the factory.

3.6 GAS SUPPLY TUBING

Gas supply tubing shall be constructed of steel or internally tinned copper with the following exceptions: Pilot lines of 1/4 inch OD (0.35 mm) or less, aluminum when properly supported, and copper tubing, which may be used on the furnaces of recreational vehicles intended for use on propane only.

PART IV
ADDITIONAL PERFORMANCE FOR FURNACES IN MOBILE HOUSING AND RECREATIONAL VEHICLES

4.1 GENERAL

In addition to the performance provisions of Part II, the provisions of Part IV shall apply.

4.2 BLOCKED AIR INLET OR FLUE GAS VENT OUTLET TESTS

Furnaces with air inlet(s) or flue gas vent outlets intended to terminate less than 6 inches (152 mm) above the roof, shall comply with 2.4, (COMBUSTION) 2.5, (BURNER OPERATING CHARACTERISTICS) 2.7, (PILOT BURNERS AND SAFETY SHUT-OFF DEVICES) and 2.16, (SAFETY LIMIT CONTROL PERFORMANCE) with the air inlet(s) or flue gas vent outlet, or both, blocked.

4.3 DUAL SOURCES OF ENERGY TEST

A furnace designed for use with alternate sources of electrical energy, shall sustain no damage when all the sources are energized simultaneously. A furnace provided with an energy selector control (see 3.10.2, (ELECTRICAL EQUIPMENT)) which does not permit simultaneous energization by more than one source of energy, shall be considered as complying with this clause.

4.4 WIND TESTS

4.4.1 The furnace shall comply with the provisions specified in 2.4, (COMBUSTION) 2.5, (BURNER OPERATING CHARACTERISTICS) and 2.7, (PILOT BURNERS AND SAFETY SHUT-OFF DEVICES) when tested at normal test pressure only and in accordance with the following Method of Test.

METHOD OF TEST

The furnace shall be installed in a test enclosure built to simulate the configuration of a typical mobile home, Figure 11, or in a mobile home and so located that either one side or back surface of the furnace is against the outside wall of the test enclosure at the manufacturer's recommended clearances.

A wind velocity, produced by a blower having sufficient capacity to develop a 40 mph (17.9 m/s) wind, shall be directed across the combustion air inlet and the outlet of the flue gas vent simultaneously at wind directions and angles specified in Figure 12. The measurement of wind velocities shall be at the point specified in Figure 12.

The furnace shall be subjected to wind velocities:

a. fluctuated between 30 mph (13.4 m/s) and 40 mph (17.9 m/s) with 30 s per cycle.

b. of 10 mph (4.5 m/s) and 20 mph (8.9 m/s).

The test shall continue until combustion reaches equilibrium.

4.4.2 The pilot burner and the main burner shall be capable of being ignited when tested according to the Method of Test specified in 4.4.1, (WIND TESTS).

4.5 RAIN TEST

Water shall not enter the enclosure, the air intake, or the flue gas vent in quantity sufficient to interfere with normal operation of the furnace or accumulate within the furnace, or the vehicle when tested in accordance with the following Method of Test.

METHOD OF TEST

The test shall be conducted with gas at normal test pressure only.

The furnace shall be installed in an enclosure as specified in 4.4.1. Rain shall be applied to the roof-jack or flue gas vent termination by an apparatus described in the current Standard CAN1-2.21 GAS-FIRED APPLIANCES FOR OUTDOOR INSTALLATION at an angle of approximately 45 degrees to the vertical, to the top and sides of the terminal in the direction most likely to cause water to enter the enclosure or terminal.

The rain shall be applied for 1 h, and at the rate of 0.118 inch/min (7 inch/h). The nozzle(s) shall be a minimum of 5 ft above the unit. The rate of rainfall shall be determined by measuring the rise of water in a straight-sided pan placed horizontally and completely within the area covered by rain.

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AIRTIGHT HOUSES AND CARBON MONOXIDE POISONING

by F. Steel

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The Problem

The operation of an air exhaust system or a fuel-burning appliance removes the air from a house, thereby creating a slight negative pressure inside the house. If too much air is removed, the negative pressure can become large enough to reverse the natural flow of gases up the furnace chimney and instead cause the chimney to become a passageway for the supply of outside air into the house. If the furnace burner is operating at that time, its products of combustion will not be able to escape through the chimney and will enter the house instead through the draft regulator on the venting system. This action may create a danger of carbon monoxide poisoning for the inhabitants.

As part of the national energy conservation program, air leakage into houses is being reduced by improved construction techniques for new houses and by the caulking and sealing of existing houses. There is concern, however, that the improved airtightness may increase the risk of carbon monoxide poisoning or asphyxiation.

Evidence of the Problem

Gas utilities and other authorities have recently expressed concern about the number of complaints from homeowners of gas odours in their houses and about the growing incidence of carbon monoxide poisonings. The poisonings are thought to be associated with insufficient air infiltration into houses and are usually connected with the operation of fireplaces. The gas odours, it is believed, are the result of an inadequate air supply into the house.

Central records show that in Canada each year about 10 people die and about 100 people receive hospital in-patient treatment as a result of carbon monoxide poisoning attributed to the incomplete combustion of domestic fuel. These records, however, do not establish a direct connection between the carbon monoxide problems and inadequate air supply or venting failure of the furnace chimney. It is possible, therefore, that some of the poisonings have been caused by chimney blockage or other factors not related to the airtightness of the house. Since central records are not kept of people treated by hospital emergency departments, in doctors' offices or by police or fire services, the figures for carbon-monoxide-related incidents remain incomplete.

The service call records of one gas distributor revealed various reasons for odour complaints, such as vapour from gasoline stored near the furnace, leaks in gas piping and extinguished pilot flames. Occasionally, gas odours that may have resulted from insufficient ventilation while the house was closed and unoccupied were not detectable after people had entered and moved about in the house. There was insufficient information to determine how many of the gas odour complaints could be directly linked to the airtightness of houses.

Although the problem of carbon monoxide poisoning does not appear to be widespread, the problem does exist. The following analysis was undertaken to determine to what extent carbon monoxide poisoning could be related to the airtightness of a house.

Possible Cause of the Problem

Recently-constructed houses are, in most cases, more tightly constructed than older houses. Smaller houses and row houses with one or more enclosing surfaces common to adjoining buildings have less exterior surface area through which air infiltration can occur. The smaller leakage area, combined with improved construction practices such as the use of tighter windows, weather stripping and caulking all tend to reduce the amount of air leakage in newer houses. The increased airtightness of these houses may cause venting failure of the chimney, which can lead to carbon monoxide poisoning.

Air Leakage Rate

The airtightness of a house can be measured by sealing intentional exterior openings and exhausting air from the house using a calibrated fan. Measurements for a number of typical new Canadian houses showed that the air leakage rate for the most airtight house was two air changes per hour under a test pressure difference of 50 Pa (0.2 in. of water).

In order to provide numerical values for this analysis, a house was invented that had the above air leakage characteristics and that was the size of an average new Canadian house. It was given a floor area of 100 m^2 (1,060 sq ft) and a volume of 480 m^3 (17,000 cu ft). Figure 1 indicates the air leakage rates at various pressure differences for this house.

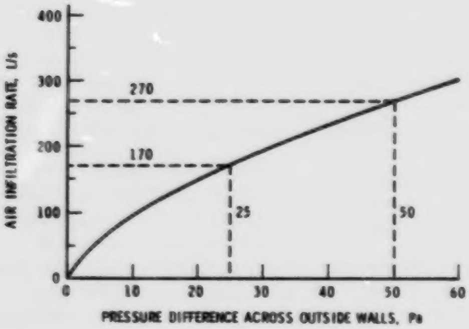

Figure 1

Air leakage characteristics of an airtight house

Negative Pressure

The natural draft, or negative pressure, created in a chimney causes the flow of gases up the chimney and can be overcome most easily when that draft is lowest. The draft created at the base of a chimney depends upon many variables, one of which is the inverse of the outside air temperature. With other variables held constant, a lower natural draft will occur at higher outside air temperatures. In this analysis, it is assumed that furnaces and fireplaces will be used until the outside air temperature reaches a maximum of 15°C (60°F). It is at this temperature, then, that the lowest natural draft will occur. At 15°C, a furnace in operation can create a draft at the bottom of its chimney of 25 Pa (0.1 in. of water), assuming a chimney height of 6 m (20 ft) and a flue gas temperature in the furnace chimney of 150°C (300°F). In the case of a fireplace in operation, the flue gas temperature can reach or exceed 800°C (1,500°F), creating a draft in excess of 50 Pa (0.2 in. of water) at the base of the fireplace chimney. (Here also, the chimney is assumed to be 6 m high and the outside air temperature, 15°C.) The larger negative pressure created when the fireplace is in use can overcome the natural draft of the furnace chimney and cause a flow of outside air down the furnace chimney. This, in turn, prevents the escape of carbon monoxide and other flue gases to the outdoors, forcing them instead through the draft regulator into the occupied space of the house. However, if there is a sufficient supply of air into the house, as a result of either leakage or intentional openings, to meet the demand of the fireplace, draft failure at the furnace chimney may not occur.

Since an exhaust fan can also cause a draft failure at the furnace chimney, the interior should be supplied with enough outdoor air while the exhaust fan is operating to prevent this.

If the negative pressure reaches 25 Pa in the house considered in this analysis, 170 L/s (360 cfm) of outside air will leak into the house (according to Figure 1). If the total air demand at any time does not exceed 170 L/s, there should be no downdraft at the furnace chimney.

Air Demand

In general, 30 litres of air are needed for each litre of gas burned: half for the combustion process and the other half for dilution at the draft regulator in order to maintain a relatively constant draft at the vent outlet of the furnace. Normally, a furnace would be rated for an input of 0.8 L/s (100 cu ft/hr) of gas and would require 24 L/s (50 cfm) of air during burner operation. A similar amount of air would be needed for a domestic oil burner of equivalent heating capacity.

A fireplace normally burns about 5 kg (10 lb) of seasoned wood per hour, producing flue gases which may contain as little as 1% carbon dioxide. Under these conditions the fireplace would consume 110 L/s (240 cfm) of room air. Many factors, such as the fuel consumption rate and flue gas temperature, vary while a fireplace is in use. These factors affect its air consumption rate so that the 110 L/s demand is not constant during its operation. Although the air demand may exceed or fall short of this amount for brief periods of time, 110 L/s represents a reasonable estimate of the amount of air needed during the operation of a fireplace.

The quantity of air moved by kitchen exhaust fans, toilet exhaust fans and clothes dryer fans varies considerably, depending upon the type and model of fan used and the length and size of the exhaust duct. Average air requirements are: 70 L/s (150 cfm) for kitchen exhausts, 20 L/s (50 cfm) for toilet exhausts and 65 L/s (135 cfm) for dryer exhausts[1]. If any of these systems are operating when a downdraft is being created in the furnace chimney, they will have to operate against the additional negative pressure (at least 25 Pa) creating the downdraft, thereby causing the volume of exhaust air to decrease to approximately 55 L/s (120 cfm) for kitchen exhaust fans, 12 L/s (25 cfm) for toilet exhaust fans and 55 L/s for dryer fans.

At 25 Pa negative pressure, the total air requirement for the furnace, fireplace and exhaust systems of the house used in this analysis is approximately 260 L/s (560 cfm). Since only 170 L/s (360 cfm) are provided by air leakage into the house, there will be an expected deficiency of about 90 L/s (200 cfm) at times when all the systems operate simultaneously. A downdraft in the furnace chimney could be created to supply this deficit. If there is no fireplace in the house or if the fireplace is not in use, the normal air leakage into the house should be enough to meet the needs of the furnace and exhaust fans, thus eliminating the possibility of a downdraft at the furnace chimney. The actual deficiency in a house at a given time depends upon the number of operating systems, the air exhaust rate of each system and the leakage characteristics of the house. Because all systems usually do not operate simultaneously, the maximum deficiency may not occur very often.

Possible Cures

The risk of carbon monoxide poisoning caused by a downdraft in a furnace chimney can be eliminated by separating the furnace from the occupied space of the house and by supplying outside air for combustion and dilution directly into the furnace room. This will ensure that the furnace does not have to compete for the limited amount of air leaking into the house. The problem can also be prevented by using a direct vented furnace in which the combustion process is isolated from the occupied space of the house and is connected directly to the outdoors. The initial costs for either of these solutions are generally high.

A solution with lower installation costs is to provide an intentional opening to the exterior for the supply of outside air. Although this modification introduces more outside air and requires more energy consumption for heating, it does ensure the safe operation of fuel-burning equipment. This solution can be implemented in a variety of ways. One means of supplying outside air is to duct it directly into the fireplace, at the same time providing a damper to stop the supply of air when the fireplace is not in use. Another method consists of supplying outside air through a wall opening into the basement space; however, this approach may result in unacceptably low temperatures in the basement. A third method, which requires installing a supply air duct from outdoors to the return air plenum of the warm-air heating system, ensures more acceptable comfort conditions. One problem with these air supply systems is that the air supply cannot be regulated. Too much air may be forced into the house if the wind blows into the opening; and not enough, if the wind blows from the opposite direction.

Costs

It costs approximately $100 to install, during construction, a short length of thermally insulated duct from the outdoors to the return air plenum of a furnace. (An air supply into a fireplace located on an outside wall may be less expensive.) At current lending rates, a $100 increase in the mortgage may incur an extra cost of $15 per year for repayment.

The costs to heat the air supply must be considered also. The free area required for a supplemental air supply system in the house used in this analysis was calculated to be 260 cm^2 (40 sq in.). This is about 28% of the average 930 cm^2 (144 sq in.) leakage area already existing in most houses. This air supply system would, in turn, increase by 28% both the amount of air infiltration and the heating costs associated with it. Assuming that about 30% of the annual heating cost is due to air infiltration, the intentional opening would therefore increase annual heating costs by about 8% in the sample house. Using a damper to stop this supplemental air supply when the fireplace is not in use would eliminate or considerably reduce the 8% increase in heating costs.

Detection of Potential Air Supply Problems

This Digest has focused on the problems presented by fireplaces since, of all the fuel-burning space heaters, fireplaces are usually the most difficult to regulate with respect to air consumption. Wood stoves and other fuel-burning space heaters can have similar effects on the air demand of a house, especially if they are operated with substantial air openings or high flue gas temperatures. The supply of an adequate amount of outside air should be considered for all fuel-burning appliances.

A potential risk of carbon monoxide can be determined using the following simple test. Although this test may be performed at any time, potential problems under the most adverse conditions can be detected if it is performed in mild weather when draft failure of the furnace chimney is most likely to occur. After closing the doors and windows of the house, start a substantial fire in the fireplace and switch on all the air exhaust systems in the house. Once this is done, light a cigarette or other type of smoke generator, hold it near the draft regulator of the furnace and note whether the smoke enters the flue pipe. If it does not or if it is blown back into the occupied space, this indicates a venting failure of the furnace chimey and a potential carbon monoxide problem if the furnace is operated under these conditions. Then open a window to provide additional outside air and repeat the test to determine if this will correct the problem. Occupants who are aware of a potential carbon monoxide problem can always take safety precautions by opening a window when using the fireplace. A more satisfactory solution, however, is to install a permanent outside air opening connected to a duct having an air outlet near or in the fireplace.

If a space heater is used, it may not be possible to connect an outside air supply duct to the heater, and providing the supply directly into the space containing the heater may lead to uncomfortably low temperatures. In that case the required supply of outside air should be ducted into the return air plenum of the furnace. A manual damper in the air supply duct that permits air to be admitted only when needed will reduce or eliminate the increased heating cost but can lead to air starvation and a resulting risk of carbon monoxide if the occupant forgets to open the damper when necessary.

Reference

1 "Design of a Mechanical Ventilation System for Future Tightly Constructed Residential Homes" by F. Perricone, Ontario Hydro Report No. 78-411-K, Toronto, 1978.

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Trade Literature:
  ACA-PAC, made by Hoyme Manufacturing Ltd.,
  Camrose, Alberta

DESIRED FEATURE FOR THE OLDER HOME

ACA-PAC makes it feasible for heating systems of older homes to be upgraded. No need for cold drafts to be drawn past doors and windows, through living rooms and dens feeding air for appliance combustion. Clothes dryers and fireplaces will no longer affect appliance fire. Fresh air will automatically be supplied directly to the appliance area by installing a COMBUSTION AIR INTAKE DUCT fitted with the automatic ACA-PAC. ACA-PAC will open for appliance combustion and close to conserve energy when fresh air is not required.

FIREPLACE REPLACEMENT AIR

Many homes require the opening of doors or windows to allow for fireplace replacement air. This air can now be effectively directed through the ACA-PAC properly installed in the furnace area. A toggle switch (optional) placed near the fireplace may be used to open the ACA-PAC allowing the inflow of this replacement air.

YOUR DEALER IS:

SPECIFICATIONS

Series: HOM - To be mounted on vertical inlet duct

Type: F1 - Control valve for one appliance maximum

Type: F2 - Control valve for two appliances maximum

Model NO - 100-XXX Fits 4" diameter duct
- 125-XXX Fits 5" diameter duct
- 150-XXX Fits 6" diameter duct
- 175-XXX Fits 7" diameter duct
- 200-XXX Fits 8" diameter duct

NOTE: Air supply to appliance area shall be in accordance with CAN1B149 and/or local codes.

When installing Fresh Air Ducts fitted with the automatic ACA-PAC use the following suggested calculations:

1 sq. in. per 8,000 Btuh input Rating of Appliance

Fresh Air Tube	Cross Section	Btuh/sq.in.	Total Max. Input of Appliances
4" dia.,	12.5 sq. in.	x 8,000 =	100,000 Btuh
5" dia.,	19.6 sq. in.	x 8,000 =	156,000 Btuh
6" dia.,	28.3 sq. in.	x 8,000 =	226,000 Btuh
7" dia.,	38.5 sq. in.	x 8,000 =	308,000 Btuh
8" dia.,	50.2 sq. in.	x 8,000 =	400,000 Btuh

When installing the F2 ACA-PAC increase diameter size of air tube by one inch after doing necessary calculations.

AUTOMATIC
ACA
ENERGY SAVER
OR
STOP
COLD AIR
FROM WORKING
AGAINST YOU

LOWER YOUR HEATING BILL!

HOYME MANUFACTURING LTD.P.O.BOX 1485,CAMROSE,ALTA. T4V 1X3
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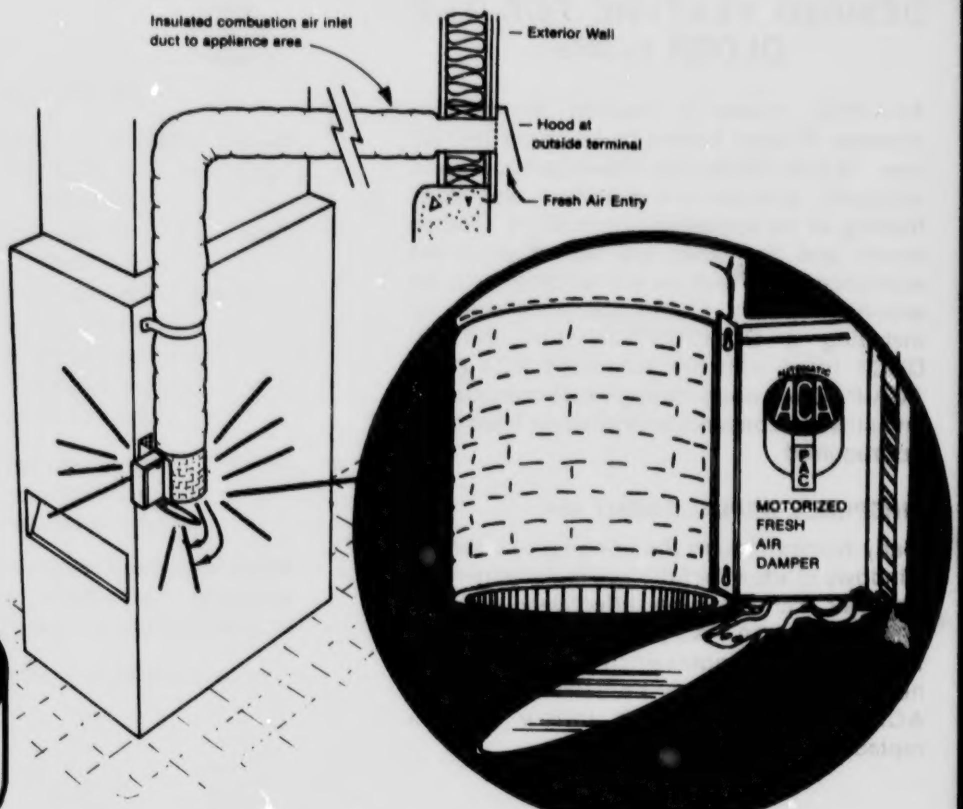
248409

AUTOMATIC ACA PAC

MOTORIZED FRESH AIR DAMPER

- ★ Approved for new and existing propane and gas fired appliances.
- ★ Interlocked with 2-wire - 24 V.A.C. thermostat systems.
- ★ Automatically opens when fresh air is required for complete combustion.
- ★ Ideal for homes that have been sealed for unwanted drafts.
- ★ Motorized for quiet operation.
- ★ Nylon bearings for many years of service.
- ★ Made from heavy gauge aluminum.
- ★ C.G.A. Certified. Electrical components C.S.A. approved.
- ★ Fresh air guaranteed for appliance fire.
- ★ Manual switch (optional) may be field installed for continuous supply of fresh air.
- ★ Designed for old and new homes. (Add fresh air duct to older homes.)
- ★ Sizes from 4 inches to 8 inches in diameter.
- ★ Accommodates up to 400,000 Btuh input rating of appliances.
- ★ Model F2 is interconnected to two appliances.
- ★ Tube is wrapped with insulation.
- ★ Mounted on outside of appliance preventing condensation on the inside.
- ★ Designed and manufactured in Canada.


Insulated combustion air inlet duct to appliance area
— Exterior Wall
— Hood at outside terminal
— Fresh Air Entry
AUTOMATIC ACA PAC
MOTORIZED FRESH AIR DAMPER

AUTOMATIC ACA PAC

SAVES ENERGY AND MONEY

Whether your home is old or new, your propane or gas heating appliance requires fresh air to burn. For the modern home, building codes have specified fresh air tubes for combustion air. For older homes, infiltration of air through poorly fitted doors, windows and open cracks has been the normal supply of combustion air.

Uncontrolled fresh air, whether through tubes or cracks, is uncomfortable, potentially unsafe and expensive to heat. In the interest of saving energy and money, this fresh air can now be safely and effectively controlled by the ACA-PAC. This combustion air damper device is thermostatically interlocked to automatically open for appliance fire and to automatically close when fresh air is not required. See your heating expert now for further details and effective fresh air control.

* Patent Pending

"Gas Appliance Installation Manual", CGA, 1976

NATURAL GAS COMBUSTION

(See also Section 8 Ventilation & Combustion Air)

What is Combustion?

In simple language, combustion means "burning" but the process actually involves the oxidation of carbon in a gas.

Natural gas will not burn unless it is mixed with oxygen which is about 20 percent of the air we breathe.

As shown in the accompanying illustration 4-1, combustion takes place when a mixture of gas and air is ignited by a pilot flame or a spark.

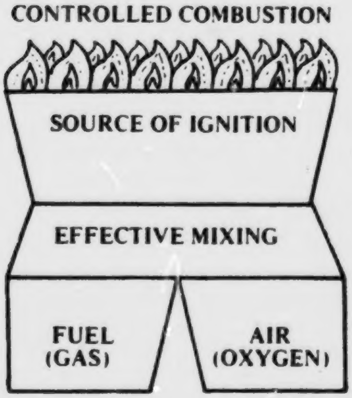


Figure 4-1

The rate of combustion is determined by the volume of gas supplied to the burner per hour.

Most natural gases produce an average of 1,000 Btu per cubic foot of gas burned. From this "total" heat, approximately 10% is generally lost to the atmosphere in the form of water vapour.

Natural gas will burn in air when the gas is between 4 and 14 percent of the mixture. Part of the air for combustion is normally supplied through the burner mixer as "primary" air. The remainder enters the combustion zone through "secondary" air openings in the appliance. Unburned gas must not be allowed to accumulate before being ignited.

Chemistry of Combustion

Without becoming too involved in scientific terms natural gas is considered to be a methane gas. The basic elements consist of one carbon atom (C) and four hydrogen atoms (H) which together form the methane molecule (CH_4).

When methane burns with sufficient oxygen (O_2) for complete combustion, the products of combustion consist of carbon dioxide (CO_2) and water vapour (H_2O).

The chemical reaction for this combustion process is illustrated in the following formula:

$$CH_4 + 2\,O_2 = CO_2 + 2\,H_2O$$

It is apparent that one molecule of methane requires two molecules of oxygen to produce one molecule of carbon dioxide with two molecules of water vapour. Similarly one cubic foot of methane burns with two cubic feet of oxygen to produce one cubic foot of carbon dioxide and two cubic feet of water vapour.

However, the two cubic feet of oxygen is acompanied by eight cubic feet of nitrogen (N_2) in the air which is unchanged in the combustion process.

The chemistry of combustion and volumes of each component are shown in the accompanying diagram.

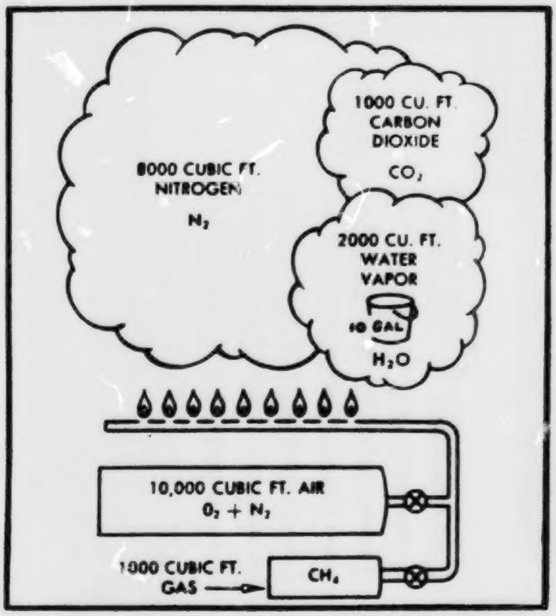

8000 CUBIC FT. NITROGEN N_2
1000 CU. FT. CARBON DIOXIDE CO_2
2000 CU. FT. WATER VAPOR
10 GAL
H_2O
10,000 CUBIC FT. AIR $O_2 + N_2$
1000 CUBIC FT. GAS
CH_4

Figure 4-2
Showing Products of Combustion from Natural Gas Burning Without Excess Air

It will be noted in figure 4-2 that when 1,000 cubic feet of natural gas is burned (without excess air) the water vapour would be about 10 gallons if allowed to condense. This fact illustrates the need to keep products of combustion above the dew point temperature in a venting system.

Incomplete Combustion

So far, the explanation of gas combustion has been based on the assumption that all of the carbon is burned completely to carbon dioxide. The products of "complete" combustion are harmless to the ecology.

If the carbon in a fuel does not burn with sufficient oxygen, a dangerous gas called carbon monoxide (CO) is produced. Most people are familiar with this hazard from automobile exhaust and particularly in a closed garage.

When new gas appliances are examined by the Canadian Gas Association, they must pass rigid tests to ensure that any carbon monoxide in the products of combustion is within extremely low limits.

It is essential that all gas appliances receive sufficient air for combustion and that the products of combustion are vented to the outdoor atmosphere. Without proper venting action, the accumulated carbon dioxide can reenter a combustion chamber and leave the appliance as carbon monoxide.

In another chapter of this manual, advice is given on the correct procedure for adjusting a conversion burner installation. It is important that flame impingement on a relatively cold surface be prevented so that the flame is not cooled below the normal combustion temperature.

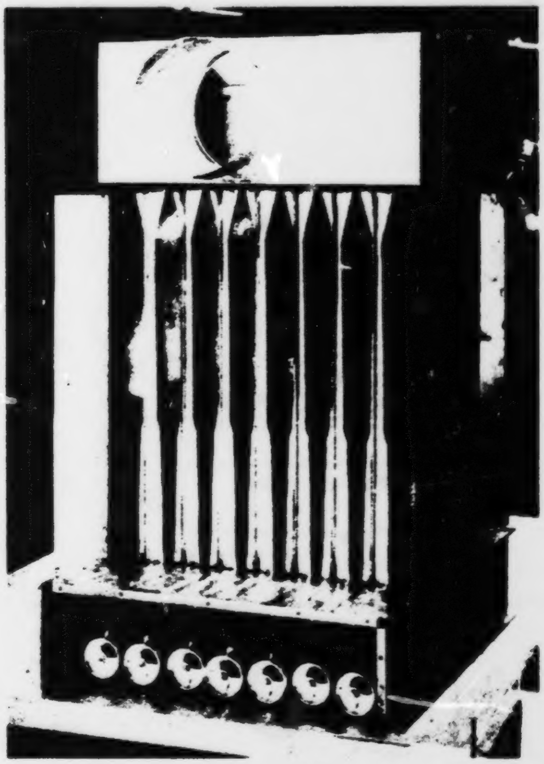


Figure 4-3
Modern Form of Wafer Type Combustion Chamber

Carbon Monoxide

Installers, servicemen and inspectors must be particularly alert to conditions that may result in formation of carbon monoxide. It is a toxic gas which means that death can occur from inhaling a relatively small concentration in the air.

It has been established by health authorities that a person may collapse after inhaling only 0.2% of carbon monoxide in air for a period of one hour. Artificial respiration and oxygen treatment must be applied immediately in such cases.

Gas Company servicemen use special detection instruments when carbon monoxide is suspected in a building. This check should be made whenever an occupant has been overcome or complains of chronic headaches or nausea.

Carbon monoxide is one product of incomplete combustion and it is odourless. Aldehydes may also be present and they are detected by their sharp, penetrating odour. Whenever aldehydes are formed, it is quite likely that carbon monoxide is also present in the mixture.

Combustion Efficiency

The term 'efficiency" in this manual is the percentage of total heat produced that is available in a useful form. For example, a gas furnace with an input rate of 100,000 British Thermal Units per hour (Btuh) having a combustion efficiency of 75% will deliver 75,000 Btuh into a home. The remaining 25,000 Btuh passes to outdoor atmosphere with the products of combustion up the chimney or vent.

In the previous review of gas combustion, it has been assumed that gas burns with exactly the correct amount of oxygen for the chemical reaction. In practice, additional air is needed in the combustion process to ensure that combustion is complete.

This "excess" air must be kept to a minimum because it becomes heated and increases the loss up the vent. In the design of gas appliances, the availability of excess air is generally made non-adjustable. However, in the case of conversion burners, the installer must set the combustion air supply to suit the rate of gas flow. Full information is given on this subject in the section describing conversion burner installations.

A detailed calculation has shown that the volume of carbon dioxide in the products of combustion would be approximately 11.9% if it were possible to burn natural gas completely without excess air. This value of 11.9% is known as the "Ultimate CO_2".

In practice, the actual CO_2 can be measured with a simple instrument or indicator by drawing out a sample of the combustion products. At the same time, a carbon monoxide indicator will show whether the combustion is complete or incomplete. Assuming that the CO_2 measurement represents complete combustion (with excess air), the percentage of CO_2 can be used as an indication of the combustion efficiency. It is also necessary to measure the flue gas temperature (ahead of the draft hood) so that the "stack temperature rise" can be determined. This term is the difference between measured temperature in the appliance outlet and the air temperature entering the combustion chamber.

The following table shows combustion efficiency in relation to the % CO_2 and stack temperature rise in degrees Fahrenheit.

COMBUSTION EFFICIENCY (NATURAL GAS)

Stack Temperature Rise

% CO_2	300	400	450	500	550	600
5	77	73	71	69	67	65
6	79.5	75.5	73.5	72	70.5	68.5
7	81	77.5	76	74	72.5	71
8	82	79	77.5	76	75	73
9	82.5	80.5	79	77.5	76.5	75

Table 4-1

In a typical gas furnace, the CO_2 will be approximately 8% with a stack temperature rise of 450 degrees F. The excess air is approximately 40% in this case.

Throughout this chapter, the process of natural gas combustion has been simplified to suit the installer's interests and responsibilities. Another chapter in this Manual provides basic information on industrial combustion systems.

VENTILATION AND COMBUSTION AIR SUPPLY

Consideration must be given to the space occupied by gas-fired appliances so that they are sufficiently supplied with combustion and ventilation air.

Where lack of attention is given to this very important part of the installation serious consequences can result such as the formation of carbon monoxide and/or carbon soot by the appliance combustion. Air supply to the gas appliance area is often insufficient and the importance of adequate air cannot be overemphasized.

Unfortunately there is no simple method available to indicate the adequacy of this air supply. Atmospheric conditions can change from day to day and even hour by hour, altering the effectiveness of the air supply in any area and only experience can dictate when all of the factors have been considered for each specific installation and assurance of sufficient air supply under all operating conditions has been obtained.

To assist in the correct interpretation of this section, these definitions are offered:

Air supply with respect to the installation of an **appliance**, means **combustion** air, flue gas **dilution** air, and ventilation air:

Combustion air means the air required for satisfactory combustion of fuel, including excess air;

Primary air means that portion of the combustion air that is supplied for the initial stages of the combustion process and is supplied upstream from the point of ignition;

Secondary air means that portion of the combustion air that is supplied for the intermediate and final stages of the combustion process and is supplied downstream from the point of ignition;

Flue gas dilution air means the ambient air that is admitted to a venting system to stabilize or neutralize the effect of chimney draft on an applaince.

Ventilation air means air that is provided to a room or space containing an appliance(s) to:

a) reduce the ambient temperature of the room
b) permit the temporary exhausting of warm contaminated air through a ventilation opening(s).
c) provide movement of air through the room or space under normal conditions.

Confined space means a space which cannot by itself, provide sufficient air supply to give adequate combustion, dilution and ventilation air for the normal operation of the appliance(s) in that space, i.e. a room within a room containing a door which can be closed. Adequate air supply shall be obtained from either adjacent areas in the building or from outdoors.

Unconfined space means the total open area within a building which would normally provide an adequate air supply to appliances in that area. Occasionally, due to heavy insulation, tight fitting storm doors and windows and sealing of walls, an additional air supply must be obtained from outdoors.

The following tables will assist you in sizing any openings which may be required:

One appliance or multiple appliances with total inputs not exceeding 400,000 Btuh

In A Confined Space

1A If air supply is from **inside** building:

Two openings are required to adjacent common air supply (from **inside** building)

Two permanent openings are required:

- **lower opening** not more than 18" and not less than 6" above floor. Free opening of not less than 1 sq. in. per 1,000 Btuh.

Input	Lower Opening
400,000 Btuh	400 Sq. In.
350,000	350
300,000	300
250,000	250
150,000	150
100,000	100
75,000	75
50,000	50

- **upper opening** as near ceiling as practicable and not lower than relief opening of draft hood or draft regulator.

  Free area not less than total area of vents and chimneys from appliances in space except for closet type installation where area not less than that of lower opening.

In A Confined Space

1B Air supply is directly from **outdoors:**

Two permanent openings directly to **outdoors** by openings or duct.

Free area of not less than 1 sq. in. per 4,000 Btuh

- **lower opening** not more than 18" or less than 6" above floor.

Input	Lower Opening
400,000 Btuh	100 Sq. In.
360,000	90
320,000	80
280,000	70
240,000	60
200,000	50
160,000	40
120,000	30
80,000	20

- **upper opening** located as near ceiling as practicable but not lower than relief opening of draft hood or draft regulator.

  Free area not less than total area of vents and chimneys from appliances in space except for closet type installation where area not less than that of lower opening.

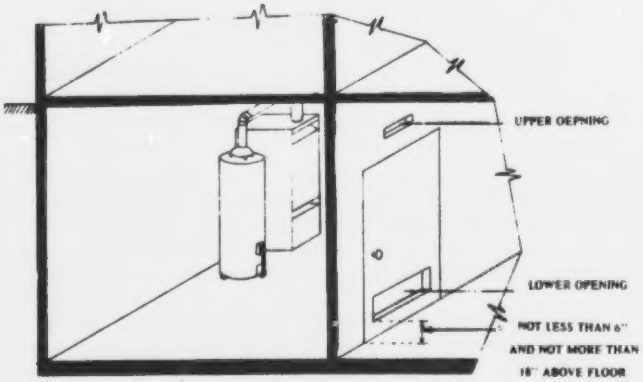


Figure 1A

APPLIANCE(S) IN A CONFINED SPACE AIR SUPPLY FROM INSIDE THE BUILDING TOTAL INPUT NOT EXCEEDING 400,000 BTUH

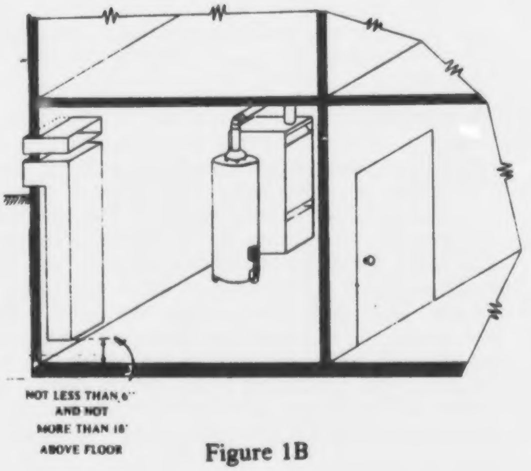


Figure 1B

APPLIANCE(S) IN A CONFINED SPACE AIR SUPPLY FROM OUTSIDE THE BUILDING TOTAL INPUT NOT EXCEEDING 400,000 BTUH

In A Confined Space

2A If a **vertical** duct to outdoors is used, a minimum of 1 sq. in. per 4,000 Btuh of total input of all appliances must be allowed.

Input	Lower Opening
400,000 Btuh	100 Sq. In.
360,000	90
320,000	80
280,000	70
240,000	60
200,000	50
160,000	40
120,000	30
80,000	20

In A Confined Space

2B If a **horizontal** duct is used, a minimum of 1 sq. in. per 2,000 Btuh of total input of all appliances must be allowed.

Input	Lower Opening
400,000 Btuh	200 Sq. In.
360,000	180
320,000	160
280,000	140
240,000	120
200,000	100
160,000	80
120,000	60
80,000	40

The smaller dimension of rectangular ducts shall not be less than 3".

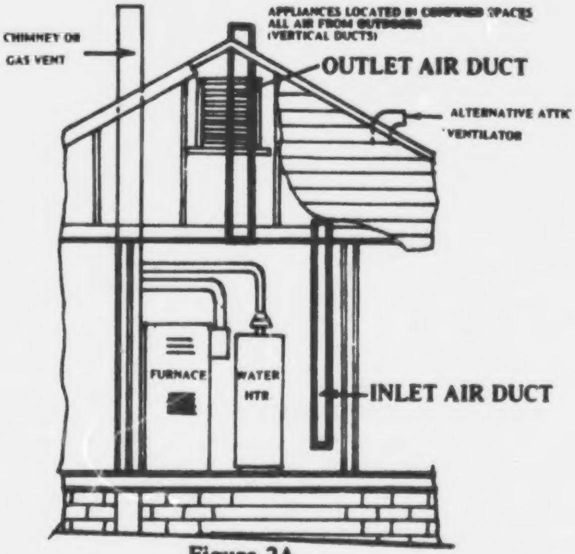

CHIMNEY OR GAS VENT
APPLIANCES LOCATED IN CONFINED SPACES
ALL AIR FROM OUTDOORS
(VERTICAL DUCTS)
OUTLET AIR DUCT
ALTERNATIVE ATTIC VENTILATOR
FURNACE
WATER HTR
INLET AIR DUCT

Figure 2A

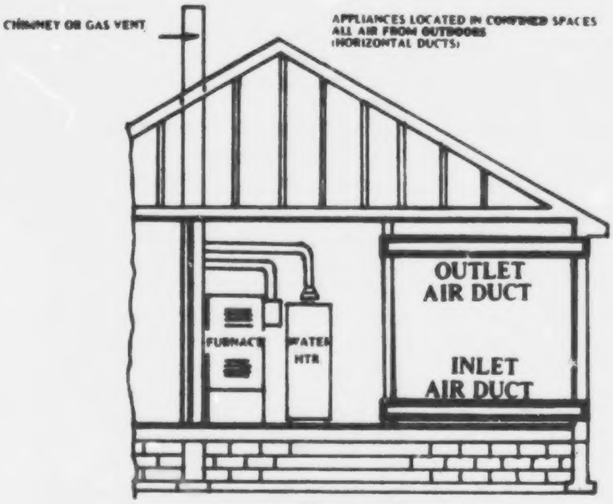

CHIMNEY OR GAS VENT
APPLIANCES LOCATED IN CONFINED SPACES
ALL AIR FROM OUTDOORS
(HORIZONTAL DUCTS)
OUTLET AIR DUCT
INLET AIR DUCT
FURNACE
WATER HTR

Figure 2B

One appliance or multiple appliances with total inputs not exceeding 400,000 Btuh

3. In An UNCONFINED SPACE

At least one permanent opening from **outdoors** located at or ducted to not more than 18" and not less than 6" above floor level.

Free area of not less than 1 sq. in. per 5,000 Btuh\of total input of all appliances.

Input Btuh	Square Inch
400,000	80
350,000	70
300,000	60
250,000	50
200,000	40
150,000	30
100,000	20
75,000	15
50,000	10

When air supply ducts are provided, their discharge point shall be located where the possibility of cold air affecting any equipment is reduced to a minimum.

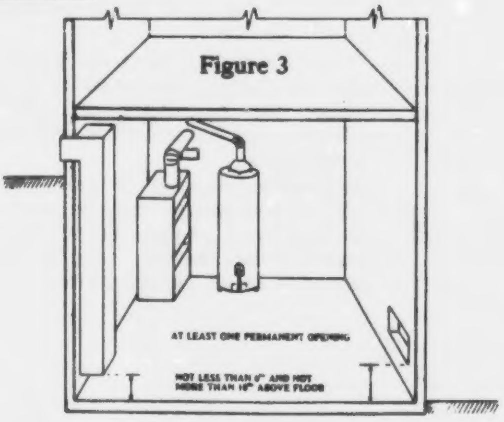


Figure 3
AT LEAST ONE PERMANENT OPENING
NOT LESS THAN 6" AND NOT MORE THAN 18" ABOVE FLOOR

APPLIANCE(S) IN AN UNCONFINED SPACE
AIR SUPPLY FROM OUTSIDE THE BUILDING
TOTAL INPUT NOT EXCEEDING 400,000 BTUH

Appliances operating in excess of ½ p.s.i.g. and/or single units or multiple units with total inputs exceeding 400,000 B.t.u.h. at any pressure.

The following requirements must be met for appliances operating in excess of ½ p.s.i.g. and/or to single units or multiple units with total inputs exceeding 400,000 B.T.U.H. at **any pressure**. A minimum of two openings to **outdoors** must be provided; one for ventilation and one for air supply.

Ventilation: The ventilation of the space shall be provided by an opening or openings at the highest practical point communicating with the **outdoors**. This must be a minimum of 10 sq. in. and at least 10% of the area required for the lower **air supply**.

Air supply: One of two sets of calculations is to be used for this purpose.

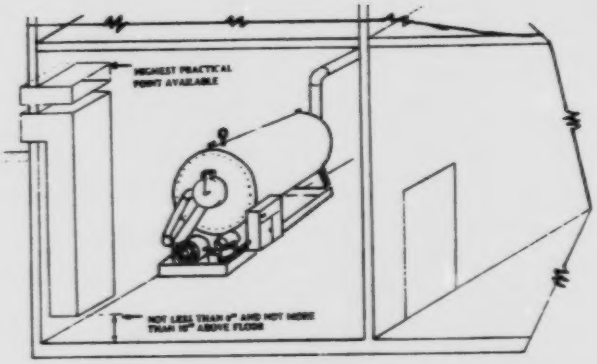
1. For the following equipment:

   natural draft (atmospheric)
   partial fan assisted
   fan assisted
   power draft assisted

   there shall be a permanent air supply opening(s), a minimum of 100 sq. in. plus 1 sq. in. for each **14,000**˙ **B.T.U.H.** in excess of 400,000 B.T.U.H., located or ducted to not more than 18" not less than 6" above floor level.
2. For **Power Burners** where there are no draft regulators, draft hoods or flue gas dilution devices, there shall be a permanent air supply openings(s) not less than 1 sq. in. for each **30,000 B.T.U.H.** of the **total rated input of the** burners(s) and its location must not interfere with the purpose of the **ventilation** air opening.

When air supply ducts are provided, their discharge point shall be located where the possibility of cold air affecting any equipment is reduced to a minimum.

Alternative methods of providing an adequate air supply may be produced by approved engineering design or make-up air heaters, suitably interlocked to an air supply system.


HIGHEST PRACTICAL POINT AVAILABLE
NOT LESS THAN 6" AND NOT MORE THAN 18" ABOVE FLOOR

APPLIANCE(S) OPERATING IN EXCESS OF ½ p.s.i.g. AND/OR TOTAL INPUT EXCEEDING 400,000 B.t.u.h. TWO OPENINGS TO OUTDOORS ARE REQUIRED.

Figure 4

TYPICAL CODE REQUIREMENTS

Mechanical **flue** exhausters may be used in **vents** or **chimneys** in lieu of **natural draft**. When such exhausters are used with **appliances** requiring **venting**, provision shall be made to prevent the flow of **gas** to main **burners** if the mechanical **flue** exhauster is not operating. Such exhausters shall not be used in **incinerators** except with the permission of the enforcing authority.

When **induced** or **forced draft** devices are used, provision shall be made to prevent flow of **gas** to the **burners** on failure of these devices.

Capacity of Round Pipes

Vent or chimney diameter	**Equivalent area**
10"	78.5 Sq. In.
9"	63.62
8"	50.27
7"	38.5
6"	28.3
5"	19.6
4"	12.7

"ANSI Z223.1 - 1984," U.S. National Fuel Gas Code

NATIONAL FUEL GAS CODE

ANSI Z223.1-1984

NFPA 54-1984

1984 Edition of ANSI Z223.1—NFPA 54

This 1984 edition incorporates changes to the 1980 edition. It was adopted by the National Fire Protection Association (NFPA) on May 23, 1984 and approved by the American National Standards Institute, Inc. (ANSI) on July 24, 1984. The ANSI designation is Z223.1-1984. The NFPA designation is 54-1984.

Changes, other than editorial, are denoted by a vertical line in the margin except as follows:

a. The three figures delineating the suggested dimensions for draft hoods have been deleted.

PREFACE

(This Preface is informative and is not part of the Code.)

This Code offers general criteria for the installation, operation and maintenance of gas piping and gas equipment on consumers' premises. It is the cumulative result of years of experience of many individuals and many organizations acquainted with the installation of gas piping and equipment designed for utilization of gaseous fuels. It is intended to promote public safety by providing guidelines for the safety and more satisfactory utilization of gas.

Changes in this Code may become necessary from time to time. When any revision is deemed advisable, recommendations should be forwarded to the Chairman, American National Standards Committee Z223, 8501 East Pleasant Valley Road, Cleveland, Ohio 44131 and the Secretary, Standards Council, National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

Minimum clearances between combustible walls and the back and sides of various conventional types of equipment and their vent connectors are specified in Part 6, Installation of Specific Equipment, and Part 7, Venting of Equipment. (Reference may also be made to the Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances, ANSI/NFPA 211.)

Equipment shall not be installed on carpeting, unless the equipment is listed for such installation.

5.3 Air for Combustion and Ventilation.

5.3.1 General:

a. The provisions of 5.3 apply to gas utilization equipment installed in buildings and which require air for combustion, ventilation and dilution of flue gases from within the building. They do not apply to (1) direct vent equipment which is constructed and installed so that all air for combustion is obtained from the outside atmosphere and all flue gases are discharged to the outside atmosphere, or (2) enclosed furnaces which incorporate an integral total enclosure and use only outside air for combustion and dilution of flue gases.

b. Equipment shall be installed in a location in which the facilities for ventilation permit satisfactory combustion of gas, proper venting and the maintenance of ambient temperature at safe limits under normal conditions of use. Equipment shall be located so as not to interfere with proper circulation of air. When normal infiltration does not provide the necessary air, outside air shall be introduced.

c. In addition to air needed for combustion, process air shall be provided as required for: cooling of equipment or material, controlling dew point, heating, drying, oxidation or dilution, safety exhaust, odor control, and air for compressors.

d. In addition to air needed for combustion, air shall be supplied for ventilation, including all air required for comfort and proper working conditions for personnel.

e. A draft hood or a barometric draft regulator shall be installed in the same room or enclosure as the equipment in such a manner as to prevent any difference in pressure between the hood or regulator and the combustion air supply.

f. While all forms of building construction cannot be covered in detail, air for combustion, ventilation and dilution of flue gases for gas utilization equipment vented by natural draft normally may be obtained by application of one of the methods covered in 5.3.3 and 5.3.4.

g. Air requirements for the operation of exhaust fans, kitchen ventilation systems, clothes dryers and fireplaces shall be considered in determining the adequacy of a space to provide combustion air requirements. See Appendix H for one method of determining adequate air for equipment operation.

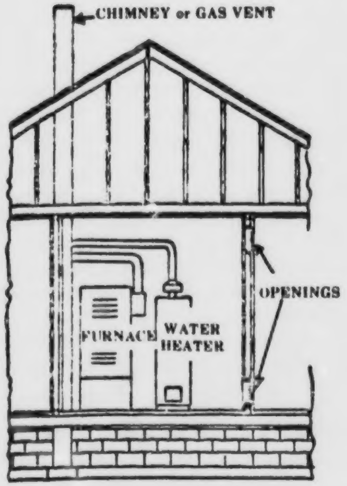
5.3.2 Equipment Located in Unconfined Spaces: In unconfined spaces (see Part 10, Definitions) in buildings, infiltration may be adequate to provide air for combustion, ventilation and dilution of flue gases. However, in buildings of tight construction (for example, weather stripping, heavily insulated, caulked, vapor barrier, etc.), additional air may need to be provided using the methods described in 5.3.3-b or 5.3.4.

5.3.3 Equipment Located in Confined Spaces:

a. All Air from Inside the Building: The confined space shall be provided with two permanent openings communicating directly with an additional room(s) of sufficient volume so that the combined volume of all spaces meets the criteria for an unconfined space. The total input of all gas utilization equipment installed in the combined space shall be considered in making this determination. Each opening shall have a minimum free area of 1 square inch per 1,000 Btu per hour of the total input rating of all gas utilization equipment in the confined space, but not less than 100 square inches. One opening shall be within 12 inches of the top and one within 12 inches of the bottom of the enclosure. (See Figure 1.)

b. All Air From Outdoors: The confined space shall be provided with two permanent openings, one commencing within 12 inches of the top and one commencing within 12 inches of the bottom of the enclosure. The openings shall communicate directly, or by ducts, with the outdoors or spaces (crawl or attic) that freely communicate with the outdoors.

1. When directly communicating with the outdoors, each opening shall have a minimum free area of 1 square inch per 4,000 Btu per hour of total input rating of all equipment in the enclosure. (See Figure 2.)
2. When communicating with the outdoors through vertical ducts, each opening shall have a minimum free area of 1 square inch per 4,000 Btu per hour of total input rating of all equipment in the enclosure. (See Figure 3.)
3. When communicating with the outdoors through horizontal ducts, each opening shall have a minimum free area of 1 square inch per 2,000 Btu per hour of total input rating of all equipment in the enclosure. (See Figure 4.)
4. When ducts are used, they shall be of the same cross-sectional area as the free area of the openings to which they connect. The minimum dimension of rectangular air ducts shall be not less than 3 inches.



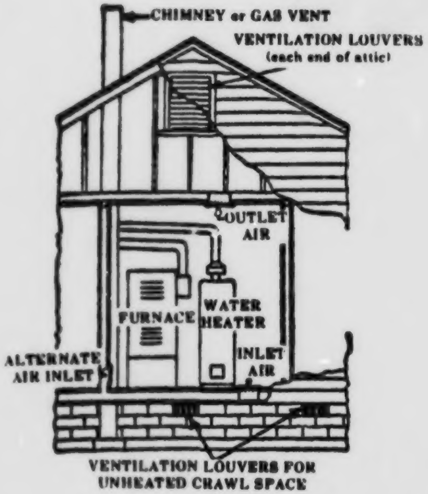
NOTE: Each opening shall have a free area of not less than one square inch per 1,000 Btu per hour of the total input rating of all equipment in the enclosure, but not less than 100 square inches.

Fig. 1. Equipment Located in Confined Spaces; All Air from Inside the Building. See 5.3.3-a.

5.3.4 Specially Engineered Installations: The requirements of 5.3.3 shall not necessarily govern when special engineering, approved by the authority having jurisdiction, provides an adequate supply of air for combustion, ventilation, and dilution of flue gases.

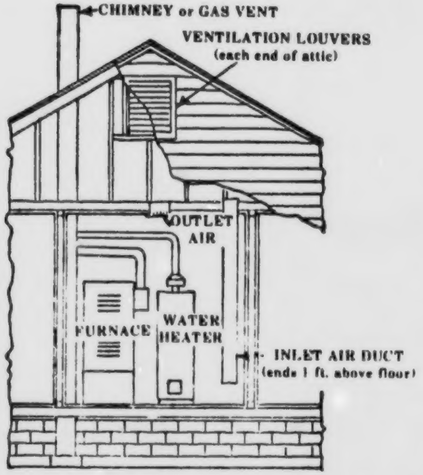
5.3.5 Louvers and Grilles: In calculating free area in 5.3.3, consideration shall be given to the blocking effect of louvers, grilles or screens protecting openings. Screens used shall not be smaller than ¼ inch mesh. If the free area through a design of louver or grille is known, it should be used in calculating the size opening required to provide the free area specified. If the design and free area is not known, it may be assumed that wood louvers will have 20-25 percent free area and metal louvers and grilles will have 60-75 percent free area. Louvers and grilles shall be fixed in the open position or interlocked with the equipment so that they are opened automatically during equipment operation.

5.3.6 **Special Conditions Created by Mechanical Exhausting or Fireplaces:** Operation of exhaust fans, ventilation systems, clothes dryers or fireplaces may create conditions requiring special attention to avoid unsatisfactory operation of installed gas utilization equipment.


CHIMNEY or GAS VENT
VENTILATION LOUVERS
(each end of attic)
OUTLET AIR
FURNACE
WATER HEATER
INLET AIR
ALTERNATE AIR INLET
VENTILATION LOUVERS FOR UNHEATED CRAWL SPACE

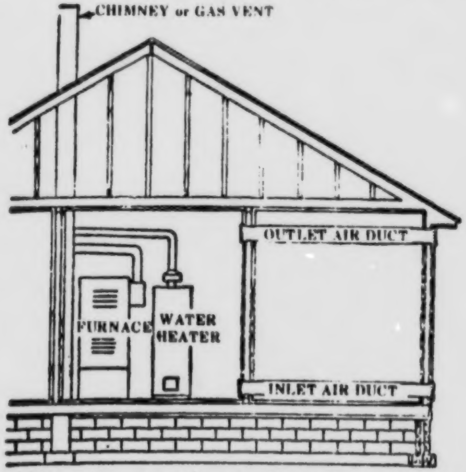
NOTE: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 Btu per hour of the total input rating of all equipment in the enclosure.

Fig. 2. Equipment Located in Confined Spaces; All Air from Outdoors — Inlet Air from Ventilated Crawl Space and Outlet Air to Ventilated Attic. See 5.3.3-b.


CHIMNEY or GAS VENT
VENTILATION LOUVERS
(each end of attic)
OUTLET AIR
FURNACE
WATER HEATER
INLET AIR DUCT
(ends 1 ft. above floor)

NOTE: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 Btu per hour of the total input rating of all equipment in the enclosure.

Fig. 3. Equipment Located in Confined Spaces; All Air from Outdoors Through Ventilated Attic. See 5.3.3-b.


CHIMNEY or GAS VENT
OUTLET AIR DUCT
FURNACE
WATER HEATER
INLET AIR DUCT

NOTE: Each air duct opening shall have a free area of not less than one square inch per 2,000 Btu per hour of the total input rating of all equipment in the enclosure.*

* If the equipment room is located against an outside wall and the air openings communicate directly with the outdoors, each opening shall have a free area of not less than one square inch per 4,000 Btu per hour of the total input rating of all equipment in the enclosure.

Fig. 4. Equipment Located in Confined Spaces; All Air from Outdoors. See 5.3.3-b.

MAY 12, 1983

COMBUSTION AIR AND VENTING OF HIGH-EFFICIENCY APPLIANCES

PREPARED BY R.L. HAY

CANADIAN GAS ASSOCIATION

CERTIFICATION DIVISION

INTRODUCTION

Canadian housing stock is becoming increasingly air-tight. This trend can primarily be attributed to two factors:

(i) the more rigorous enforcement of air/vapour barrier requirements and the introduction of 'super-insulation' techniques in new housing construction; and

(ii) the implementation of retrofit measures such as insulating, caulking, and weatherstripping, in existing houses.

While air-tightness is desirable as a means of improving the energy efficiency of dwellings, it may prove deleterious if adequate ventilation of the indoor space is not maintained. Replacement of interior air is necessary to control humidity levels and to prevent the build-up of excess concentrations of indoor air contaminants. Inadequate air change rates can therefore lead to condensation problems and health problems for occupants. Insufficient ventilation may also impact on the performance of combustion appliances. It is this latter concern that will be addressed in this presentation.

Combustion Appliance Performance Problems Associated with Tight Buildings

When allowance is not made for the adequate ventilation of an air-tight building, two types of problems may arise in relation to the performance of a combustion appliance:

(i) corrosion of appliance components and venting system due to contaminated combustion air;

(ii) nullification of the "stack effect" in the chimney and subsequent spillage of combustion products.

In the first instance, inadequate ventilation of the indoor space causes indoor air to become polluted with contaminants generated both by building occupants and by processes which occur in the building. Such contaminants may include chlorides, organic gases emitted from building materials and furnishings, dust, carbon dioxide, odours, etc. Contaminated indoor air is subsequently drawn into the combustion chamber of the appliance, where it is mixed with fuel and ignited. Products of combustion and excess air are then expelled through the venting system of the appliance.

In a high-efficiency appliance with low flue-gas temperatures, water vapour laden with contaminants may condense in the appliance and/or in the venting system, leading to the formation of corrosive agents such as hydrochloric acid. When the condensate then evaporates, the concentration of the corrosive substance increases, and deterioration of the appliance or vent material is accelerated (See Figure 1). In a conventional furnace, a similar situation occurs when combustion products containing contaminants condense in the appliance heat exchanger (e.g. during start-up of the appliance) (see Figure 2).

Incidences of this type of deterioration of flue pipes and heat exchangers are documented in References 1 and 2.

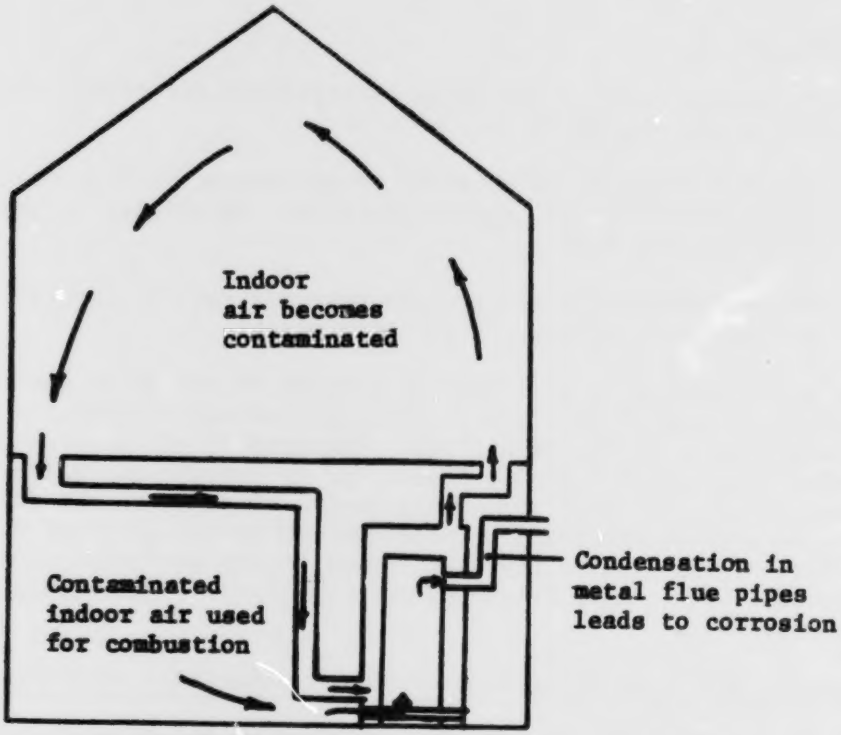

Indoor air becomes contaminated
Contaminated indoor air used for combustion
Condensation in metal flue pipes leads to corrosion

FIGURE 1

HIGH-EFFICIENCY FURNACE

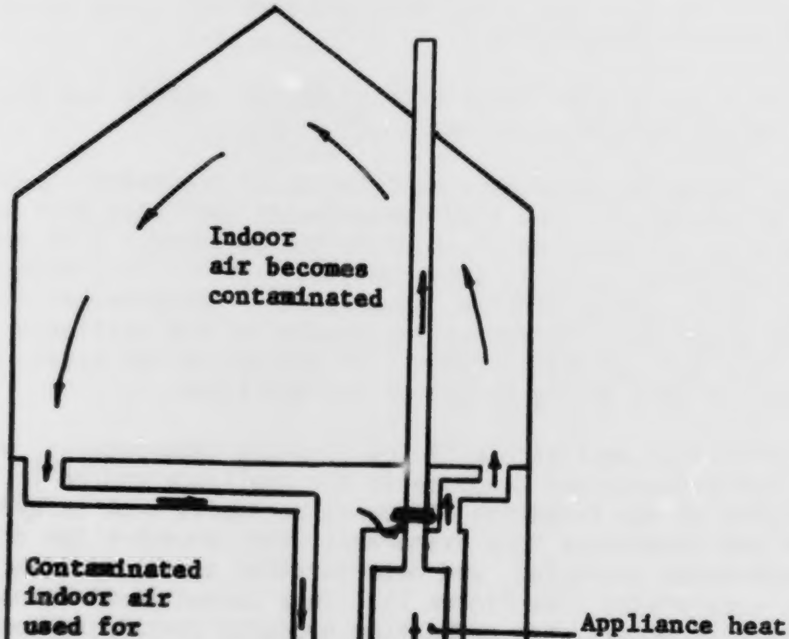

Indoor air becomes contaminated
Contaminated indoor air used for combustion
Appliance heat exchanger

FIGURE 2

CONVENTIONAL FURNACE

The second type of problem associated with the operation of a combustion appliance within a tightly-sealed building is that of spillage of combustion products. This occurs when the chimney stack effect is nullified by negative pressure created within the building by:

(i) the operation of mechanical exhaust devices (e.g., kitchen and bathroom fans, clothes dryers);

(ii) fireplaces;

(iii) external wind conditions; and

(iv) the appliance chimney itself, when there is insufficient infiltration to replace exhausted air.

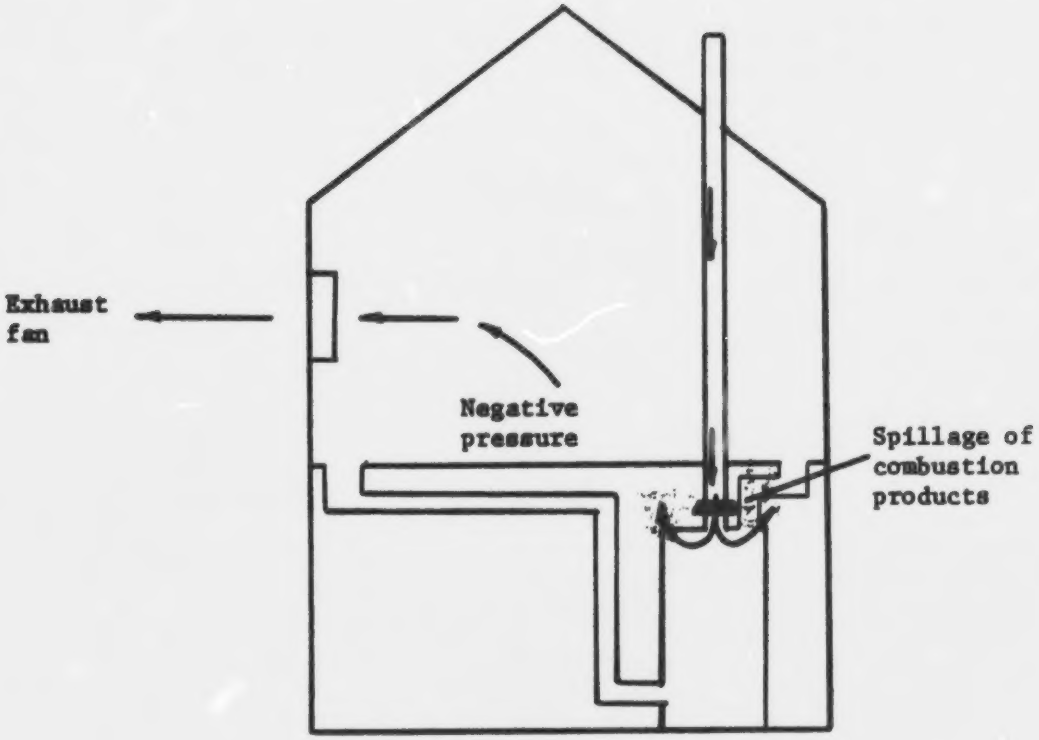

Exhaust fan
Negative pressure
Spillage of combustion products

FIGURE 3

SPILLAGE OF COMBUSTION PRODUCTS

Existing B149 Installation Code Requirements for Venting & Ventilation

The current B149 Installation Codes for Natural Gas and Propane Burning Appliances and Equipment (CAN1-B149.1/.2 M80) provide separate requirements for appliances located in "confined" and "unconfined" spaces.

Section 6.2 contains the following provision for appliances located in unconfined spaces:

> **6.2 Appliances Located in Unconfined Spaces**
>
> **6.2.1 When an *appliance* is located in an unconfined space within a *building* having insufficient infiltration, the *air supply* shall be obtained from outdoors by means of a permanent opening, or openings, having a total free area of not less than 1 inch^2 per 5000 Btuh (450 mm^2 per kW) of the total input rating of all *appliances*. The opening or openings may be connected to the cold air return of a heating system.**

Comments:

With reference to Clause 6.2.1, the question arises as to how the adequacy of building infiltration is gauged, since "insufficient infiltration" is not defined quantitatively.

Also with regard to Clause 6.2.1, there are three problems associated with the connection of an air supply opening to the cold air return of a heating system.

Firstly, the supplied air is not transmitted directly to the combustion chamber of the appliance, but rather, is distributed to the indoor space, where it becomes contaminated with indoor pollutants. The appliance then utilizes the contaminated air for combustion, and corrosion problems ensue.

Secondly, the admission of supply air into the cold air return of the appliance serves to pressurize the indoor space. This situation is undesirable, as moisture-laden indoor air is driven outward and condensation may occur within the building envelope (Figure 4).

And thirdly, the return air duct fills with cold air when the appliance circulating air blower is not operating. Upon start-up of the blower, the thermally-activated control shut-off switch is immediately cooled by the cold return air, and blower shut-off occurs. This causes severe thermal shock to the heat exchanger of the appliance.

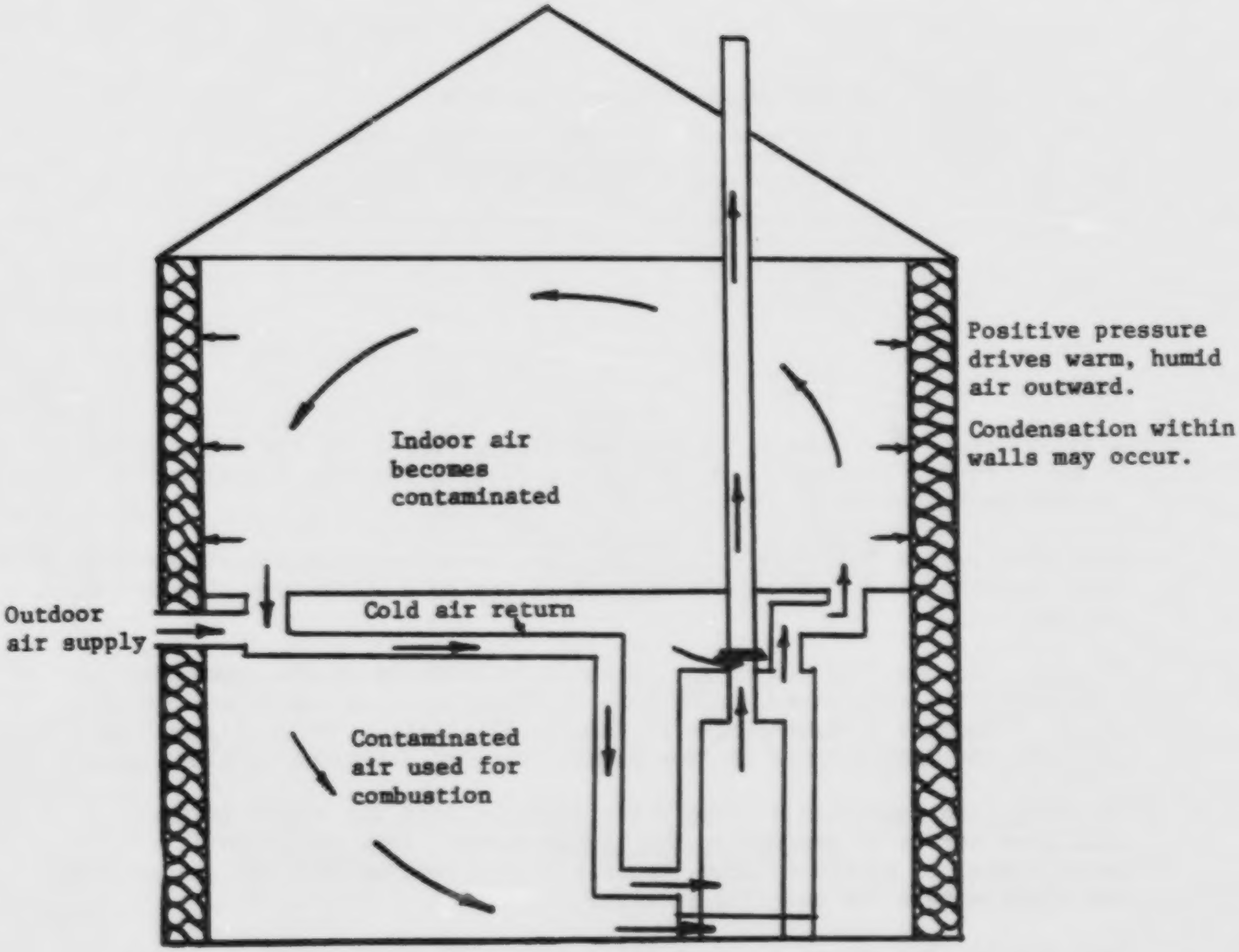

Positive pressure drives warm, humid air outward.
Condensation within walls may occur.
Indoor air becomes contaminated
Outdoor air supply
Cold air return
Contaminated air used for combustion

FIGURE 4

Section 6.3 of the Code contains the following requirements for appliances located in confined spaces:

6.3 Appliances Located in Confined Spaces

6.3.1 When an *appliance* is located in a confined space and all the *air supply* is from inside the *building*, the space shall be provided with two permanent openings freely communicating with interior areas having, in turn, adequate infiltration from outside. The openings shall conform to the following:

(a) the lower opening shall not be more than 18 inches (450 mm) nor less than 6 inches (150 mm) above floor level and shall have a free opening of not less than 1 inch^2 per 1000 Btuh (2225 mm^2 per kW) of the total input rating of all *appliances* in the space;

(b) the upper opening shall be located as near the ceiling as is practicable, but not lower than any relief opening of a *draft hood* or *draft regulator* and shall have a free area not less than the total area of all *vents* or chimneys from the *appliances* contained therein, except for closet type installations, where the area shall be not less than that of the lower opening.

Comments:

As with Clause 6.2.1, the means of determining the adequacy of air infiltration is not defined.

In new and retrofitted houses that are tightly sealed, "adequate infiltration" from outside the building to interior areas may not occur.

Hence sufficient air will not be provided to the confined space, regardless of the air supply openings recommended in 6.3.1(a) and (b).

6.3.2 When an *appliance* is located in a confined space and the *air supply* is from the outdoors, the space shall be provided with two permanent openings that communicate directly to the outdoors by means of openings or ducts. The openings shall conform to the following:

(a) the lower opening shall be not more than 18 inches (450 mm) nor less than 6 inches (150 mm) above the floor level and shall have a free opening of not less than

  (i) 1 inch² per 2000 Btuh (1100 mm² per kW) of the total input rating of all *appliances* in the space when communication with outdoors is by means of a horizontal duct or,

  (ii) 1 inch² per 4000 Btuh (500 mm² per kW) of the total input rating of all *appliances* in the space when communications with outdoors is directly by an opening or by means or a vertical duct and,

(b) the upper opening shall be located as near the ceiling as is practicable, but not lower than any relief opening of a *draft hood* or *draft regulator* and shall have a free area not less than the total area of all *vents* and *chimneys* from the *appliances* contained therein, except for a closet type installation where the area shall be not less than that of the lower opening.

Comments

As reported in Reference 4, the enforcement of the requirements in Clause 6.3.2 leads to excessive chilling of the appliance room. Occupants then block the air supply openings, discontinuing the supply of combustion air to the appliance.

In addition, Clause 6.3.2 does not limit the distance between the indoor termination of the air supply openings and the appliance itself.

> **6.3.3** When an *appliance* is located in a confined space and the *ventilation air* is from inside the *building* and the *combustion* and *draft hood dilution air supply* is from outdoors,
>
> (a) the space shall be provided with an opening for *ventilation* sized and located in accordance with Clause 6.3.1(b) and,
>
> (b) one permanent *air supply* opening shall be provided for *combustion* and *draft hood dilution air* that communicates directly with outdoors. This opening shall have a free area of not less than 1 inch^2 per 5000 Btuh, (450 mm^2 per kW) of the total input rating of all *appliances* in the confined space and may be connected to the cold air return of a heating system.

COMMENTS

In a downdraft situation caused by negative pressure in the building, spilled products of combustion will not be contained in the confined space due to the presence of the ventilation opening specified in 6.3.3(a).

While 6.3.3(b) recognizes the need for a separate supply of combustion air to the appliance, it permits the air supply to be connected to the cold air return of the heating system. As previously noted on page 5, this is undesirable.

Recommendation

In light of evolving energy-efficient construction practices and the increasing employment of retrofit techniques to tighten buildings, it can no longer be assumed that air infiltration into buildings is normally sufficient to provide air required for appliances and adequate indoor air quality. There is an urgent need to recognize the increased air tightness of new and existing housing stock, and modify appliance combustion air requirements accordingly. (Reference 5).

In this regard, CGA recommends that the following measures be implemented:

(i) the isolation of all combustion air from the rest of the living space, and

(ii) the provision of a separate outdoor air supply directly to, or within close proximity to, an appliance burner or burner vestibule.

It is believed that these measures could be incorporated in the Installation Codes by the replacement of current Sections 6.2 and 6.3 with the following requirements.

6.2 Isolation of Appliances

6.2.1 The combustion air supply to an appliance shall be isolated from the air supply of the living space either by

(a) design of the appliance (e.g. direct vent), or

(b) installation

6.3 Air for Combustion

6.3.1 For appliances, other than the direct vent type, the appliance shall be located in a confined space which is isolated from the rest of the living space, and air from the outdoors shall be supplied to within 12" of the appliance burner or burner vestibule. The cross sectional area of the air supply opening shall be 1 in^2/8000 Btuh of input rating.

(Based on an equivalent length of 25' of duct)

Rationale

The "aerodynamic isolation" of combustion air from circulating air is desirable for three important reasons:

(i) An adequate supply of fresh air for combustion would be maintained at all times. The likelihood of incomplete combustion and the resultant production of carbon monoxide would be reduced.

(ii) The corrosion of conventional and high-efficiency furnace heat exchangers and high-efficiency furnace venting systems (due to the presence of contaminants in combustion air) would be considerably reduced.

(iii) Isolation of the combustion system from the living space would permit the independent development of Building Code requirements for ventilation air for occupants.

Both CMHC and ANSI committees have recommended a similar approach.

References

1. "Corrosion of Gas-Fired Heat Exchangers", Khoo, S.W. and Williamson, F.D.

   Report published by the Canadian Gas Association, July 1973.

2. Correspondence and New Release from Arkla Industries Inc.

   Correspondence dated April 13, 1983 between Mr. R.L. Hay, CGA and Mr. R.H. Merrick, Vice President, Engineering and Research, Arkla Industries Inc.

3. "A Study of Residential Combustion-Air Requirements and Air Supplies"

   Report prepared for Gas Safety Branch, Ministry of Labour, Province of British Columbia by B.C. Research.

4. "Study of Furnace Room Design and Operation in Apple Hill Homes"

   Phase I - Inspections, June 1982
   Phase II - Monitoring, June 1982

   "Results of Pre-Alteration Testing on Apple Hill Furnace Rooms" January, 1983.

   Reports prepared for Technical Research Division of Canada Mortgage and Housing Corporation by Cogeneration Associates Ltd.

5. "Indoor Air Pollution: A Serious Health Hazard"

   Report by National Indoor Environmental Institute, Plymouth Meeting, Pennsylvania, U.S.A.

R2000 Program Requirements
August, 1984

Revised Aug 1, 1984

Technical Requirements
To March 31,1985

1. Energy Performance Criteria

The annual space heating requirement for each home is determined by computer simulation. The minimum standard of performance is to be derived from the following formula:

$$E_{TOTAL} \text{ (kWh)} = 10,600 + [\, (5 + \frac{45 \times D.D.)}{6000} \times M \,]$$

where:

- E_{TOTAL} = the total annual energy target in kWh.
- The term in the () brackets is the envelope heat loss target per square meter of floor area.
- D.D. represents the annual degree-days in Celsuis degrees for the location of the home.
- The term in the [] brackets is the maximum allowable building skin heat loss target in kWh.
- M is the equivalent floor area in square meters calculated as:

  the interior heated volume of the house (including basement), based on the inside dimensions, in cubic meters, divided by 2.5.

- 10,600 represents the non-space heating energy consumption target in kWh. Standard values of 14 kWh/day for domestic hot water, 14 kWh/day for appliances & lighting, and 3.2 kWh/day for occupancy will be assumed for computer simulation.
- At the design stage a natural infiltration and exfiltration rate of 0.00 air changes per hour (ACH) will be assumed.
- A continuous ventilation rate of .5 ACH is assumed.
- Normal indoor temperatures are defined as 21 C for living space and 18 C for basement space. A maximum temperature swing of 5.5 C shall be used except when the solar contribution exceeds 45%, in which case a temperature swing of 3.5 C shall be used.
- The efficiency of all Heat Recovery Ventilators (Air to Air Heat Exchangers) will be according to the R-2000

Heat Recovery Ventilator Efficiency Ratings.

2. Air Leakage

The house shall be constructed to test at 1.5 ACH or less at a pressure differential of 50 pascals.

The test shall be performed according to the R-2000 Air Leakage Test Guidelines by a qualified contractor. The completed R-2000 Air Leakage Test Report shall be submitted to the Canadian Home Builders' Association (CHBA).

3. Ventilation

There shall be a demonstrated capability to supply 0.5 air changes per hour or a minimum of 50 l/s (100 cfm), whichever is greater, of continuous variable speed controlled mechanical ventilation for the whole building. The ventilation distribution system shall provide continuous ventilation air to each room of the house.

Mechanical ventilation equipment, including air to air heat exchangers or similar heat recovery ventilators , shall be installed in accordance with the R-2000 Home Program Guidelines For The Design And Installation of Ventilation Equipment by a qualified contractor. Form "A" (Ventilation Equipment Installation Report), shall be completed and submitted to CHBA.

4. Replacement Air

Consideration must be given to supply replacement air for all appliances exhausting air from the home. For example, clothes dryers, power vented range hoods and central vacuum systems. Ventilation equipment such as air to air heat exchangers shall not be used for this purpose unless specifically designed for this application.

5. Combustion Equipment

All gas and propane fired space and water heating equipment shall have balanced (sealed combustion units), induced or forced draft flue systems. Such appliances shall not require 'dilution air' downstream of the appliance heat exchanger and shall be capable of positive shut down in the case of venting failure.

Oil-fired equipment, where it is permitted, shall be provided with automatic flue dampers and provision shall be made to supply combustion and dilution air to the appliance at a temperature of not less than 10 C unless manufacturer's specifications permit lower temperatures for combustion air.

All solid fuel-fired appliances such as woodstoves and fireplaces shall be equipped with tight-fitting doors, dampers, and chimney connections. These appliances shall be installed with a separate outdoor air supply designed to meet the total combustion air requirements of the appliance.

Other unvented combustion appliances shall not be installed unless adequate provision is made to vent the by-products of combustion.

6. Furnace Rooms

Furnace rooms shall not be incorporated into the home unless the design ensures that adequate combustion air is available and that the furnace room air temperature is high enough to prevent the build up of moisture or ice in the furnace flue.

7. Windows

Windows shall be at least double glazed with a minimum air space of 12.5 mm between the panes.

8. Wall Construction

Exterior above-grade walls shall have a total component resistance factor greater than R.S.I. 3.50.

9. Water Heaters

Water heaters shall have factory installed insulation with a minimum of RSI 1.75 (R10).

A "Heat Trap" or insulation for the first 3m of hot water pipe shall be installed. The hot water tank should normally be set at a temperature no higher than 50 C (120 F).

10. Appliances

Where a builder includes appliances as part of the home he shall offer the homeowner the option of selecting appliances within the upper 33% of the Energuide rating for that appliance category.

11. Proposed Changes

Recognizing that this Program is designed to encourage Builder innovation and creativity, the above criteria may be amended if changes are identified and agreed to in advance by the Builder, Canada and the Canadian Home Builders' Association.

THIS PUBLICATION INCLUDES THE FOLLOWING SECTIONS:

(1) ANSI/ASHRAE/IES 90A-1980 (SUPERSEDES SECTIONS 1-9 OF ASHRAE/IES STANDARD 90-75)

(2) ASHRAE/IES 90B-1975 (SECTIONS 10 AND 11 OF ASHRAE/IES STANDARD 90-75)

(3) ASHRAE 90C-1977 (SECTION 12 AS PUBLISHED FEBRUARY 16, 1977)

CLARIFICATION OF THE STATUS OF EACH SECTION IS INCLUDED IN THE FOREWORD.

ASHRAE STANDARD

ENERGY CONSERVATION IN NEW BUILDING DESIGN

ASHRAE Standards are updated on a five-year cycle; the date following the Standard number is the year of approval. The latest copies may be purchased from the ASHRAE Publication Sales Department, 1791 Tullie Circle, NE, Atlanta, GA 30329
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open, refrigerated food display cases, or computers or other equipment contributing a large amount of heat to the area served.

6.3.2 Where components from more than one supplier are used to function as the unitary equipment, it shall be the function of the system designer to determine compliance with these requirements, using data provided by the component supplier (See Section 6.2).

6.3.3 Coefficient of Performance (COP)—Cooling. This is the ratio of the rate of net heat removal to the rate of total on-site energy input to the air conditioner, expressed in consistent units and under designated rating conditions (See Tables 6.1, 6.3.1 and 6.3.2).

The rate of net heat removal shall be defined as the change in the total heat content of the air entering and leaving the equipment (without reheat).

Total on-site energy input shall be determined by combining the energy inputs to all elements supplied with the package of the equipment, including but not limited to, compressor(s), compressor sump heater(s), pump(s), supply-air fan(s), return-air fan(s), condenser-air fan(s), cooling-tower fan(s) and circulating water pump(s), and the HVAC system equipment control circuit.

6.3.3.1 In the case where any of the above elements is incorporated in the HVAC system, but not furnished as part of the package (covered by the manufacturer's Model No.), it is the system designer's responsibility to take the corresponding on-site energy inputs into account in determining the system performance and annual energy consumption.

6.4 Efficiency Requirements for Applied HVAC System Components, Electrically Operated, Cooling Mode. HVAC System Components, as listed in Tables 6.4 and 6.5, whose energy input is entirely electric, shall, at the Standard Rating Conditions specified in Table 6.3.1 for water-chillers and hydronic system water-source heat pumps, and Table 6.3.2 for condensing units, and at additional Standard Rating Conditions specified in applicable standards for particular system components, have an Energy Efficiency Ratio (EER) as defined in Sec. 3, or a Coefficient of Performance (COP)—Cooling, as defined in 6.4.1 and qualified in 6.4.2, not less than the values shown in Tables 6.4 and 6.5.

6.4.1 Coefficient of Performance (COP)—Cooling. This is the ratio of the rate of net heat removal to the rate of total on-site energy input, expressed in consistent units and under designated rating conditions. (See Tables 6.3.1, 6.3.2, 6.4 and 6.5).

The rate of net heat removal from the component is defined as the difference in total heat contents of the water or refrigerant entering and leaving the components.

Total on-site energy input to the component shall be determined by combining the energy inputs to all elements and accessories as included in the component, including but not limited to compressor(s), internal circulating pump(s), condenser-air fan(s), evaporative-condenser cooling water pump(s), purge devices, and the HVAC system component control circuit.

6.4.2 Where the motor-compressor, evaporator, or condenser is supplied by different manufacturers, it shall be the function of the system designer to determine compliance with these requirements, using data provided by the suppliers of the elements (see Section 6.2).

6.5 COP Requirements for HVAC System Equipment—Heat Operated, Cooling Mode

6.5.1 Efficiency Limitation, Equipment. Heat-operated cooling equipment shall have a COP—Cooling not less than the values shown in Table 6.7 when tested at Standard Rating Conditions shown in Table 6.6. These requirements apply to, but are not limited to, absorption equipment, engine-driven equipment, and turbine-driven equipment.

6.5.2 Electrical Auxiliary Inputs. Table 6.7 defines the COP for equipment in a footnote, which excludes electrical auxiliary inputs from the calculation of COP. However, this input shall be included by the system designer in the calculation of the annual energy consumption of the building, or of the total HVAC system COP.

6.6 HVAC System Combustion Heating Equipment

6.6.1 Residential/Commercial Furnaces and Boilers. These include oil- and gas-fired residential furnaces and boilers as defined in the Federal Register Vol. 43, No. 91-May 10, 1978, 430.2 Definitions, page 20154[29] (see Section 3); to vented home heating equipment, as defined therein; and to commercial furnaces and boilers with inputs under 117 kW (400,000 Btu/h).

6.6.1.1 Minimum Required Steady State Efficiencies. All gas- and oil-fired residential furnaces and boilers, and all vented home-heating equipment, shall, when tested in accordance with the applicable DOE furnace test procedures, have not less than the minimum steady state combustion efficiency specified in Table 6.8.

6.6.2 Commercial/Industrial Furnaces and Boilers. For the purposes of this standard, all gas- or oil-fired furnaces and boilers not included in the definitions specified in 6.6.1 shall be referred to as commercial/industrial furnaces and boilers.

6.6.2.1 Minimum Required Steady State Efficiency. All gas-and oil-fired commercial/industrial furnaces and boilers shall, when tested in accordance with applicable standards have not less than the minimum steady state combustion efficiency specified in Table 6.8.

6.6.2.2 Combustion Efficiency. Combustion efficiency of commercial/industrial furnaces and boilers is defined as 100 percent minus stack losses in percent of heat input. Stack losses are:

a. Loss due to sensible heat in dry flue gas
b. Loss due to incomplete combustion

c. Loss due to sensible and latent heat in moisture formed by combustion of hydrogen in the fuel

and shall be determined as provided by applicable standards. (See Section 6.2).

6.6.3 Adequate Combustion Air. a. Residential/Commercial Installations. a. Residential and Commercial Installations. For residential and commercial installations with inputs under 117 kW (400,000 Btu/h), it is the system designer's responsibility either to establish that the total minimum calculated infiltration rate will provide sufficient combustion air for fuel-fired equipment, or to provide positive means for introducing adequate outdoor air for that purpose.[32,33]

b. Commercial/Industrial. For commercial/industrial installations with inputs 117 kW (400,00 Btu/h) and over, a machine room, or boiler or furnace room, or installation outdoors, shall be provided as required to insure adequate direct outdoor air supply and to comply with governing local codes or ordinances.

6.7 COP Requirements for HVAC System Heating Equipment—Heat Pumps, Heating Mode. Heat pumps whose energy input is entirely electric, shall at the Standard Rating Conditions specified in Table 6.9 and other Standard Rating Conditions specified in applicable standards for particular types of heat pumps (see 6.7.1), have a Coefficient of Performance (COP)—Heating, as defined in 6.7.3, not less than the values shown in Table 6.10.

Note: Heat pumps used only for the heating function of a complete HVAC System shall be considered as HVAC System Components.

6.7.1 These requirements apply to, but are not limited to unitary (central) heat pumps (air source and water source) in the heating mode, to water source (hydronic) heat pumps as used in Multiple Unit Hydronic HVAC Systems and to heat pumps in the packaged terminal air-conditioner and room air-conditioner forms, in the heating mode.

6.7.2 Where elements, such as indoor or outdoor coils, from more than one supplier are used as parts of the unitary heat pump, it shall be the function of the system designer to determine compliance with these requirements, using data provided by the component suppliers (see Section 6.2).

6.7.3 Coefficient of Performance (COP)—Heating. This is the ratio of the rate of net heat output by the heat pump to the rate of total on-site energy input to the heat pump, expressed in consistent units and under designated rating conditions. (See Tables 6.9 and 6.10).

The rate of net heat output shall be defined as the change in the total heat content of the air entering and leaving the equipment (not including supplementary heat).

Total on-site energy input to the heat pump shall be determined by combining the energy inputs to all elements, except supplementary heaters, of the heat pump, including, but not limited to, compressor(s), compressor sump heaters, pump(s), supply-air fan(s), return-air fan(s), outdoor-air fan(s), cooling-tower fan(s), and the HVAC system equipment control circuit.

6.7.3.1 In the case where any of the above elements including supplementary heaters are incorporated in the HVAC System, but not furnished as part of the package (covered by the manufacturer's Model No.) it is the system designer's responsibility to take the corresponding on-site energy inputs into account in determining the total HVAC System performance and annual on-site energy consumption.

6.7.3.2 Most hydronic heat-pump systems utilize condenser-rejected heat from air conditioners serving building central core areas needing cooling during the heating season, or other available waste heat, to raise the temperature of the water from its value leaving the heat-pumps serving the perimeter of the building, to its required value entering the heat pumps. Where the quantity of such reclaimed heat is not sufficient, it must be supplemented by additional new on-site energy and, during cooling operation, on-site energy supplied to the evaporative cooling device. It is the system designer's responsibility to take these energies into account in determining total HVAC system performance and annual on-site energy consumption.

6.7.4 Supplementary Heater. The heat pump shall be installed with a control to prevent electric supplementary heater operation when the heating load can be met by the heat pump alone.

Electric supplementary heater operation is permitted during transient periods, such as start-ups, following room thermostat set-point advance, and during defrost.

A two-stage room thermostat, which controls the supplementary heat on its second stage, shall be accepted as meeting this requirement. The cut-on temperature for the compression heating shall be higher than the cut-on temperature for the supplementary heat, and the cut-off temperature for the compression heating shall be higher than the cut-off temperature for the supplementary heat. Supplementary heat may be derived from any source including, but not limited to, electric resistance heating, combustion heating, or solar or stored-energy heating.

6.8 Electric Resistance Comfort Heating Equipment. The manufacturer of electric resistance comfort heating equipment shall make available to prospective purchasers, designers, or contractors, upon request, full-load energy input, over the range of voltages at which the equipment is intended to operate. Where electrically-operated fans, blowers or pumps are integrally incorporated, or separately furnished, their electrical input shall be included by the system designer as part of the energy input to the equipment.

6.9 Maintenance. Equipment and components which require preventive maintenance to maintain efficient operation shall be furnished with complete necessary maintenance information. Required routine maintenance actions shall be clearly stated and incorporated on a readily accessible label, which may be limited to identifying, by title and/or publication number, the

GENERAL REFERENCES FOR SECTIONS 1 THROUGH 9

1. ANSI Standard C1—"National Electrical Code", 1978
2. ASHRAE HANDBOOK & Product Directory, Fundamentals Volume, ASHRAE, 345 East 47th Street, New York, NY 10017—1977
3. IES Lighting Handbook—5th Edition, Illuminating Engineering Society of North America, 345 East 47th Street, New York, NY 10017
4. ANSI/ASHRAE Standard 55-74, "Thermal Environmental Conditions for Human Occupancy"
5. ARI Standard 310-70, "Standard for Packaged Terminal Air Conditioners", Air Conditioning & Refrigeration Institute, Arlington, VA 22209
6. ANSI Standard Z234.1—1972, "Room Air Conditioners", ANSI, New York, NY 10017
7. ARI Standard 240-77, "Air Source Unitary Heat Pump Equipment", Air Conditioning & Refrigeration Institute, Arlington, VA 22209
8. ANSI/ASHRAE Standard 62-73 "Natural and Mechanical Ventilation"
9. ASHRAE HANDBOOK & Product Directory, Fundamentals Volume, Chapter 19-Thermal Insulation and Water Vapor Barriers, ASHRAE, 345 East 47th Street, New York, NY 10017—1977
10. Ibid, Chapter 20-Moisture in Building Construction
11. Ibid, Chapter 21-Infiltration and Ventilation
12. Ibid, Chapter 22-Design Heat Transmission Coefficients
13. Ibid, Chapter 23-Weather Data and Design Conditions
14. Ibid, Chapter 24-Heating Load
15. Ibid, Chapter 25-Air Conditioning Cooling Load
16. Ibid, Chapter 26-Fenestration
17. ASHRAE HANDBOOK & Product Directory, Systems Volume, ASHRAE, 345 East 47th Street, New York, NY 10017, 1976
18. ASTM E-283-73 "Standard Method Test for Rate of Air Leakage through Exterior Windows, Curtain Walls and Doors", ASTM, Philadelphia, PA, 1973
19. ASHRAE HANDBOOK & Product Directory, Applications Volume, ASHRAE, New York, NY, 1978
20. ASHRAE HANDBOOK & Product Directory, Equipment Volume, ASHRAE, New York, NY, 1979
21. SMACNA, Heating and Air Conditioning Systems — Installation Standards, 8224 Old Courthouse Road, Vienna, Virginia 22180, February 1977
22. SMACNA, Low Pressure Duct Construction Standards, 5th edition, Washington DC, 1976
23. SMACNA, High Pressure Duct Construction Standards, 3rd edition, Washington DC, 1975
24. SMACNA, Fibrous Glass Duct Construction Standards, 4th edtion, Washington DC, 1975
25. ASHRAE HANDBOOK & Product Directory, Systems Volume, Chapter 37, Service Water Heating, 1976.
26. ANSI C72.1-72, "Household Automatic Electric Storage-Type Water Heaters", ANSI, New York, NY, 1972.
27. Energy Calculations I: "Procedures for Determining Heating and Cooling Loads for Computerizing Energy Calculations- Algorithms for Building Heat Transfer Subroutines," ASHRAE, New York, NY, 1975
28. Energy Calculations II: "Procedures for Simulating the Performance of Components and Systems for Energy Calculations," 3rd edition, ASHRAE New York, NY, 1975
29. Federal Register, Vol. 43, No. 91, May 10, 1978, p. 20154.
30. IES Lighting Power Budget Determination by Unit Power Density Procedure, Illuminating Engineering Society of North America, 345 East 47th Street, New York, NY 10017, 1980.
31. ARI Standard 380-78, "Packaged Terminal Heat Pumps," Air Conditioning & Refrigeration Institute, Arlington, VA 22209.
32. NFPA 31 "Installation for Oil Burning Equipment" (ANSI Z 95.1) 1978.
33. NFPA 54 National Fuel Gas Code (ANSI Z 223.1) 1974.

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M. COMBUSTION EQUIPMENT ROOMS

(1) A combustion equipment room may contain mechanical or electrical equipment in addition to combustion appliances, but no provision shall be made in it for general storage or laundry facilities.

(2) All walls, floors and ceilings that separate a combustion equipment room from the habitable spaces of a dwelling unit or building shall be constructed with an air barrier, installed in conformance with Subsection 26C.

(3) Fire separations of a combustion equipment room shall be in conformance with Subsection 10 I.

(4) A combustion equipment room shall be provided with a tightly-sealed, weatherstripped door or other closure in conformance with Subsection 6E, swinging into the room and equipped with a self-closing device conforming with 6H(9).

(5) All equipment in a combustion equipment room shall be located so as to permit access for servicing.

(6) Provision shall be made for the replacement of all equipment located in a combustion equipment room.

(7) Clearances around combustion equipment in a combustion equipment room shall be in conformance with Section 34.

N. UTILITY ROOMS

(1) All equipment in utility rooms shall be located so as to permit access for servicing.

(2) Provision shall be made to permit the replacement of all equipment located in utility rooms.

(3) Utility rooms that may be used for the storage of hazardous substances shall be constructed in conformance with the requirements governing the storage of such substances in Part 3 of the NBC [see also 33B(6)].

(4) Fire separations of a utility room shall be in conformance with Subsection 10 I.

SECTION 34. HEATING AND AIR-CONDITIONING

A. SCOPE

(1) This Section applies to the design and installation of heating systems, appliances and equipment (such as furnaces, boilers, service hot-water heaters, solid fuel stoves and cooking equipment) in which the heat input to the system or appliance or equipment does not exceed 120 kW and to air-conditioning systems in which the rated fan capacity does not exceed 2 m^3/s.

(2) Where the heat input of a heating system exceeds 120 kW or the rated fan capacity of an air-conditioning system exceeds 2 m^3/s, Part 6 of the NBC shall apply.

(3) Masonry fireplaces shall conform to Section 22.

B. GENERAL

(1) Residential buildings intended for use in the winter months on a continuing basis shall be equipped with heating facilities capable of maintaining an indoor air temperature of 22°C at the outdoor winter design temperature, except as provided in (2). Winter design temperatures shall be determined in conformance with Article 2.3.1.1. of the NBC.

(2) NBC Heating facilities shall be provided which shall be capable of maintaining a temperature not less than 18°C in an unfinished basement. Where crawl spaces are required to be heated, the heating facilities shall be capable of maintaining a temperature of not less than 15°C.

(3) NBC The design, including heat loss and heat gain calculations, for the construction and installation of heating and air conditioning systems shall conform to good engineering practice such as the procedures described in the ASHRAE Guide and Data Books, the ASHRAE Handbooks, the HRAI Digest, the Hydronics Institute Manuals and the SMACNA Manuals.

(4) Appliances and electric equipment shall be installed to conform to the following:

CSA B51, "Code for the Construction and Inspection of Boilers and Pressure Vessels,"

CSA B52, "Mechanical Refrigeration Code,"

CSA B139, "Installation Code for Oil Burning Equipment,"

CAN1-B149.1, "Installation Code for Natural Gas Burning Appliances and Equipment,"

CAN1-B149.2, "Installation Code for Propane Burning Appliances and Equipment," and

CSA C22.1, "Canadian Electrical Code, Part 1."

NBC CSA B365, "Installation Code for Solid-Fuel Burning Appliances and Equipment".

(5) Where an oil-fired combustion appliance is provided with a mechanical chimney flue damper, the damper shall conform to CSA 140-14, "Automatic Flue Dampers for use with Oil Fired Appliances".

(6) Where a supplementary or alternate heating system is installed, it shall conform in every respect to the requirements of this Section.

(7) Equipment forming part of a heating or air-conditioning system, except for concealed or embedded pipes or ducts, shall have easy access for inspection, maintenance and cleaning.

(8) NBC Heating systems or appliances using solid fuel shall not be connected to heating systems incorporating an oil-burning or gas-burning appliance or to an electrical heating device unless it can be shown that the total system is designed so that unsafe temperatures or water pressures will not occur with the operation of all or part of the combined system.

C. SUPPLY OF AIR TO COMBUSTION APPLIANCES

(1) Except as provided in (2), a combustion appliance that is designed to discharge the products of combustion to the outdoors through a flue shall be supplied with air for the purposes of combustion and dilution from the outdoors to the appliance, in a manner that prevents the interaction of the combustion and dilution air with the air in the room or space.

(2) Where combustion appliances or equipment are located in a combustion equipment room or enclosure, they shall be supplied with air from the outdoors in sufficient quantity for purposes of combustion and dilution. The supply of air shall not result in ambient temperatures within the service room or enclosure of less than 10°C. [see also B(4)].

(3) Air supplied to combustion appliances using liquid or gaseous fuels shall be at a temperature of not less than 10°C, unless the manufacturer's instructions permit lower temperatures for combustion air.

(4) Dilution air shall be at a temperature of not less than 10°C before it comes in contact with products of combustion.

(5) All ducts and openings supplying air to combustion appliances shall meet the requirements of B(4) and shall conform to the requirements of Subsection 33E.

D. ISOLATION OF COMBUSTION PRODUCTS FROM LIVING SPACES

(1) Where appliances are installed that are designed to discharge the products of combustion to the outdoors through a flue, the products of combustion shall be prevented from being drawn into habitable rooms or spaces under the action of other appliances or ventilation systems, either by the design of the appliance (including air intakes, flues, enclosures, and access panels or doors), or by the appliance being installed in a combustion equipment room which conforms to C(2) and Subsection 5M.

(2) For the requirements for fire separations between combustion appliances and habitable spaces, see Subsection 10 I.

E. DUCTS FOR LOW-CAPACITY AIR HEATING SYSTEMS

NBC

The design, construction and installation of air duct distribution systems serving heating systems in which the rated heat input does not exceed 120 kW shall conform to Subsections F,G,H and I, and to Subsection 6.2.3 of the NBC.

K. RADIATORS, CONVECTORS AND HEAT EXCHANGERS

(1) Every heat exchanger or unit heater using hot water or low pressure steam shall be installed with sufficient clearance to ensure that the temperature of any combustible material will not exceed its safe limit.

(2) Every steam or hot water radiator or convector attached to a wall or located in a recess or concealed space containing combustible material shall be provided with a noncombustible backing.

L. STOVES, RANGES AND SPACE HEATERS BURNING SOLID FUEL

(1) Stoves, ranges and space heaters burning solid fuel shall meet the requirements of Subsections 34B, 34C and 34D and CSA-B365.

(2) Stoves, ranges and space heaters burning solid fuel that are designed to operate with doors to the combustion chamber in an open position shall not be constructed or installed.

(3) NBC Space heaters burning solid fuel shall conform to ULC S627/CSA B366.2, "Standard for Space Heaters for Use with Solid Fuels".

(4) Stoves, ranges and space heaters burning solid fuel shall be installed in a room or space sufficiently large to permit accessibility to the appliance.

(5) NBC A stove, range or space heater burning solid fuel shall be connected to a chimney in accordance with Section 21.

(6) The minimum clearance between stoves, ranges or space heaters burning solid fuel and combustible material, whether or not such material is covered with noncombustible material such as plaster, shall conform to Table 34B, except that where protection is provided as described in Table 34C the clearance may be reduced in conformance to that Table.

(7) NBC Protection described in Table 34C consisting of sheet material spaced out from a wall, shall have at least 25 mm edge clearance along the bottom and 75 mm along the top. Protection spaced out from a ceiling shall have 75 mm edge clearance on at least 3 sides.

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COMMENTARY

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SECTION 34: HEATING, COMBUSTION EQUIPMENT AND AIR CONDITIONING

This Section has been greatly revised from the 1980 Residential Standards mainly in conformance with the layout of the proposed revisions for the 1985 edition of the National Building Code. The dual underlying objectives of the Section remain unchanged, however; First to ensure that buildings are heated adequately and secondly to achieve this in a safe manner. The first objective is achieved quite simply by specifying the inside temperature to be maintained with a given outside design temperature. The second requires that careful attention be given to the details of the installation to ensure that the products of combustion are discharged to the outdoors and that suitable clearances are maintained between the components of the system and combustible material.

Clauses B(1) to B(3) define the inside temperature conditions that the heating system must be able to maintain, give a reference as to how the design outside temperature is to be established and give guidance as to how the design calculations are to be performed. B(1), B(2) and B(3)

Some combustion equipment is designed with an airtight casing that allows the combustion and dilution air to be ducted straight from the outdoors without contact with the air in the room or space in which the equipment is located. It is considered that the use of equipment of this type is the solution to the problem of ensuring that the products of combustion cannot be drawn into the habitable parts of the building. Unfortunately there is as yet only a limited number of such appliances but more are being developed. Clause C(1) is, therefore, given priority as being the way to go for the future. Clause C(2) recognizes that at present it is probable that conventional equipment that draws its air supply from the room within which it is located will have to be used in most cases. Such equipment must be located in a combustion equipment room [See D(1)] and the required resistance to the back drafting of the gases is provided by the walls, ceiling and floor of that room (See Subsection 5M). C(1), C(2)

C(3), C(4) Most combustion equipment does not function well at low temperatures. Oil does not atomize satisfactorily, for example, leading to incomplete combustion. Similarly cold dilution air leads to a cold chimney with a loss of draft and possible condensation problems. Dilution air should never be ducted straight from the outdoors.

D(1) Clause D(1) states the basic safety requirements that the products of combustion must never be drawn into the habitable spaces in the building. It gives the designer the option either of using suitable equipment that is designed and constructed from air intake to flue gas discharge to provide this separation or of separating the appliance from the rest of the building by a specially designed enclosure. The design and construction of such an enclosure will require special care to make the separation airtight. Furnace rooms as constructed conventionally in the south will not meet these requirements.

Subsections E to I Subsections E to I are largely a reordering, in accordance with the proposed revisions for the 1985 National Building Code, of the existing requirements.

L(1), L(2) Combustion appliances that burns solid fuel can constitute a safety hazard just as much as can oil or gas fired appliances. Hence they must meet the same requirements for the separation of combustion and dilution air from the room air. Unfortunately, they have two additional difficulties in doing so. First, because they require manual reloading heat by radiation as well as convection, the majority of such appliances must be installed in the habitable spaces and so cannot be located in a separate combustion equipment room. Secondly, the draft produced by an operating solid-fuel stove can vary greatly - from over 150 L/s down to nothing. A roaring fire produces a strong draft that could backdraft other equipment, but as the fire burns down the draft is reduced, eventually becoming zero when it goes out. Meanwhile, the flue must remain open while the fire is dying out, and it could then be backdrafted by ventilation exhaust fans, pulling combustion gases back into the dwelling. In the interests of safety, therefore, it is clear that these appliances must have combustion chambers which remain completely closed except at the time of refuelling. Combination stoves, that can be operated with the front open as an open fire, will therefore not be permissible under Subsection L.

SECTION 35: ELECTRICAL FACILITIES

The 1985 draft NBC has updated the reference to the CSA Code to the current 1982 edition. A(2)

A clause has been added to ensure that service panels have adequate capacity for modern requirements. A(5)

Clauses A(6) and A(7) are intended to protect the integrity of the air-vapour barrier. This is a very important part of the NRS, since most projections of performance in the NRS are based on the assumption that the air-vapour barrier is intact, and since punctures and tears are a very common consequence of electrical work. It is strongly suggested that the best way of avoiding the problem is to keep wiring out of the building envelope; if this is impossible, then the use of poly pans will reduce the possibility of problems. A(6), A(7)

Although the CSA Code is referenced in A(2), it was decided to add A(8) to draw attention to a specific new clause in the 1982 CSA Code dealing with wiring in insulated walls. A(8)

Clause A(9) is aimed at ensuring that penetrations of the building envelope are sealed, and that deterioration is not caused by incompatible materials. A(9)

This clause is intended to reduce the possibility of overheating of service panels which could occur in an insulated space. A(11)

The requirements for ground fault interruptors are covered in the CSA Standard, which is a required reference in this Section, but a specific reference has been added here to improve the chances of adherence. A(13)

MOBILE HOME APPLIANCE STANDARDS AND AIRTIGHT HOMES

A Review of Current Mobile Home Standards
Covering Fuel-Burning Appliances to Assess
Their Applicability to Airtight Homes

A Project of the
Energy Conservation and Oil Substitution Branch
Energy, Mines and Resources Canada

Prepared by
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ABSTRACT

Fuel-burning appliances installed within the envelope of airtight houses will tend to experience a lack of combustion air unless special provision for an adequate air supply is made.

Mobile homes, because of their relatively small interior volume and "tight" construction, have used such appliances for many years and Standards have been developed to cover these outside-aired direct vent appliances. This report reviews existing mobile home fuel-burning appliance standards and assesses their applicability to airtight housing. Also included is a current list of fuel-burning appliances certified for use in mobile homes and a partial list of other appliances not certified for use in mobile homes, that might prove useful in airtight housing.

The report finds that existing mobile home furnace, space heating, and gas-fired service water heater appliance Standards appear adequate for use in airtight housing, with only minor revisions; however, existing appliances are only certified for use in mobile homes and adaptation for use in airtight housing will require careful consideration of many installation details.

Modifications to existing appliance installation codes or a new installation code for fuel-burning appliances in airtight housing is recommended.

Conventional fuel-burning appliances (e.g. furnaces, water heaters, cooking appliances, clothes dryers, etc.) installed within the building envelope of airtight housing will tend to experience a lack of combustion air resulting in incomplete combustion and the generation of carbon monoxide in potentially lethal quantities.

If fuel-burning appliances (as opposed to electric appliances) are to be used in future airtight housing, special provision will have to be made for an adequate supply of combustion air and the venting of products of combustion.

This report reviews existing Standards developed by the Canadian Standards Association, Canadian Gas Association, and Underwriters' Laboratories of Canada, covering oil and gas-fired furnaces and water heaters, solid fuel fired space heaters and fireplaces, and gas-fired cooking appliances for use in mobile homes and their respective installation codes to assess their applicability to airtight housing.

Also included is a list of appliances currently certified for use in mobile homes giving manufacturer's name and address, model number, certifying agency, and any special remarks attached to the certification. Appliance certification is dependent on installation requirements specific to mobile homes and may not apply if installed in airtight housing.

A speculative partial list of alternative appliances, not certified for use in mobile homes, is also included.

Existing mobile home furnace, space heater, and gas fired water heater appliance standards appear adequate for use in airtight housing with only minor modifications. Future revisions more appropriate to airtight housing will likely evolve as the market for these appliances develops. There are several certified space heating appliances available and their usefulness will depend on successfully matching the furnace output to the home heat loss. It is emphasized that such appliances are certified for use in mobile homes only and that adaptation for use in airtight housing will require careful consideration of installation factors such as furnace location, ducting of combustion air, venting of products of combustion, etc. Other common appliances used for cooking, clothes drying, etc. are not of the sealed combustion, direct vent design. Usefulness in airtight housing will depend on method of installation or development of new direct vent appliances. Modifications to existing installation codes or a new installation code covering fuel-burning appliances in airtight housing is recommended.

(1) Modifications to existing appliance installation codes or a new installation code for fuel-burning appliances in airtight housing is recommended. The proposed Standard could cover at least the following aspects:

(a) Acceptable appliances; (referencing the appropriate product standard)

(b) Furnace size recommendations;

(c) Appliance location, air supply, venting details;

(d) Fresh air supply;

(e) Alternate approaches to direct vent appliances;

(f) Use of automatic flue vent dampers; and

(g) Where the use of electric appliances is recommended.

(2) If fuel-fired appliances such as water heaters, cooking appliances, refrigerators and clothes dryers are to be used in airtight housing, new direct vent appliances need to be developed as well as appropriate Standards for these appliances.

SOLID FUEL BURNING APPLIANCES
FOR USE IN
LOW ENERGY HOUSING

Prepared for

THE STANDARDS DIVISION
CANADIAN STANDARDS ASSOCIATION

Submitted by:

ENERGY PATHWAYS INC.
Ottawa, Ontario

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1.0 INTRODUCTION

Since 1974, a series of safety standards have been developed for the testing and certification of solid fuel burning appliances. Following the practice established in standards for other fuel burning devices, special requirements were included for appliances intended for use in mobile homes. The requirements were designed to contend with two conditions which may affect appliance safety and which were considered likely to be encountered in mobile homes. The first relates to the capability of these buildings to be moved from one location to another with the appliance installed inside. The second relates to the relatively small enclosed volume and construction specifications which result in low air infiltration rates.

Our purpose here is to review the existing requirements for mobile home appliances and to assess their applicability for appliances intended for use in low energy or "airtight" housing. An initial observation would indicate that those aspects of the requirements that relate to the "mobility" of mobile homes are not applicable to appliances used in airtight houses; the physical shock, vibration and tipping that could be encountered during the transportation of a mobile home will not occur. It will, therefore, be those aspects of the requirements that relate to air infiltration and access to combustion air that this review and assessment will have as its focus.

3.5 SUMMARY OF MOBILE HOME APPLIANCE TEST REQUIREMENTS

	Central Systems B366.1/B140.10	Space Heaters B366.2/S627	Fireplaces S610
1. Attachment to Floor	Yes	Yes	Yes
2. Placement on Combustible Flooring	Yes	Yes	Yes
3. Combustion Air from Outdoors	Yes	Yes	Yes
4. Venting and Air Duct Components Tested and Supplied with Unit	Yes	Yes	Yes
5. Chimney Attached Directly to Appliance	No	Under review	Yes
6. 100% Air Damper Closure and Interlock to Flue Damper	No	Yes	Yes
7. Air Duct Size	1 sq. in./5,000 Btu/h	1/2 flue collar area	1/2 flue collar area
8. Rough Usage Drop Test	No	Yes	Yes
9. Negative Pressure Test	No	Yes	Yes
10. Wind Test	Yes	recently adopted	No
11. Barometric Draft Control Prohibited	Yes	Yes	Yes

4.0 CONCLUSIONS

4.1 Agreement

The requirements for mobile home appliances in the three standards subjected to detailed review are not in agreement with each other. Table 3.3 illustrates the variations in test procedures. The differences between the tests for fireplaces and space heaters are relatively minor but the requirements for central systems vary considerably from the other two. Any action resulting from the current interest in solid fuel-burning appliances for use in low energy housing should attempt to resolve this problem. The differences in appliance-type will cause the actual procedures and test assemblies to differ but the standards should address the same issues and share the same intent.

4.2 Wind Test

Several issues arise in relation to the wind test. First, although B366.1 for central systems and B366.2/S627 for space heaters both require this test, no solid fuel burning systems available on the Canadian market have been subjected to it. No appliances have been tested to the mobile home requirements of B366.1 and the wind test was recently adopted by B366.2/S627 and has not yet been applied. The fireplace standard S610 does not require the test.

Second, the wind test should ensure that both the chimney and air duct caps are of a design that prevents the severe pressurization of the system under high wind velocity conditions. However, it does not deal with the potential for system pressurization and backdrafting resulting from the dynamics of airflow over and around a building. While it is unlikely that any laboratory test could predict or duplicate this effect, consideration could be given to a construction requirement of a balance-type backdraft damper located in the combustion air duct.

Third, the test assembly in B366.2/S627 calls for a chimney termination which communicates freely with the space from which the combustion air is taken (see clause 12.1.3 and figure 1A). The wind test specifies a 65 km/h wind directed at the chimney just below its termination. Unless this reviewer has missed something significant, it is apparent that this test would cause combustion products to spill into the test facility. This result has been experienced by one certification agency during a wind test trial (not a certification program test). This test, while it has merit and should be included, should be reviewed for its practicality in light of the other requirements in the standard.

Consideration should be given to including a wind test in standard S610.

4.3 Negative Pressure Test

This is a very severe test. During a receding fire, the natural draft developed by a chimney can easily fall below 17.5 pa. The relative air tightness of the air duct, appliance and chimney assembly are all that would prevent a spillage of combustion products into the enclosure.

The negative pressure test is the single most important test relating to appliances intended for use in mobile homes. Appliances that are able to pass this test should be safe in an airtight house unless there is a source of extreme negative pressure. Other Standards for airtight housing should ensure that building pressures are maintained well below this level.

4.4 Instructions and Cautions

The information requirements in the standards for space heaters and fireplaces for use in mobile homes appear to be complete. On the other hand, the requirements in the central systems standard are inadequate to inform installers and users of the particular areas of concern with woodburning appliances in mobile homes.

The instructions and cautions specified in these equipment standards do not provide sufficient information for appliances to be used in low energy housing. The main area in which further information is needed is in identifying for the users of both the standards and the appliances tested to them, the conditions for their application. For example, it is a straightforward matter to distinguish a mobile home from other types of structures; the terminology is clear and they are visually different. The description and specifications of low energy homes are vague and possibly confusing for the non-specialist. As well, it is possible to retro-fit conventional houses to approximate the specifications for low energy housing. The class of appliances under discussion here should be used in these retro-fitted buildings. Users need clear information to assist them in determining the degree of air tightness in a given building and the level at which an outdoor-aired appliance should be used to ensure the safety of the building's inhabitants.

5.0 RECOMMENDATIONS

5.1 Agreement

The intent of the applicable equipment standards must be brought into agreement. It is essential that the general specifications among the standards for both mobile home and low energy housing appliances be consistent. This will help to prevent confusion on the part of retailers, contractors and installers of the equipment. In turn, users of the appliances will be more likely to receive accurate and reliable information from these groups.

5.2 Test Specifications

The key tests that illustrate the safety of these appliances in low energy housing should be carefully reviewed. The negative pressure test should be reviewed in light of this new application. The goal of this review would be to ensure that it is fair to appliance manufacturers and at the same time provide sufficient confidence that appliances tested to it will operate safely under the negative pressure conditions that can be anticipated in low energy housing. The wind test also needs to be reviewed for its practicality and compatibility with other test requirements.

5.3 Terminology

The terminology used to describe appliances for use in low energy housing should be clarified. For example, the terms mobile home appliance, outdoor-aired and direct vent are used almost interchangeably to describe appliances suitable for use in mobile homes. A new class of appliances is likely to emerge as a result of the low energy housing initiative. The opportunity is presented to send a clear message, through the use of descriptive terminology, to those who need to know the importance of their proper application.

Two options for such a term using the acronyms for Super Energy Efficient Housing and Low Energy Housing are:

SEEH Type Appliances and
LEH Type Appliances

Another option is:

Air Tight Housing Appliances

Other suitable options may be identified for this purpose.

5.4 Instructions and Cautions

The information provided to installers of these appliances should assist them in determining the conditions under which their use is mandatory, optional or unnecessary. Attempts should be made to simplify these criteria as much as possible.

5.5 Action

The responsible technical committees for at least the three equipment standards reviewed in this report should be encouraged to review and revise the standards in concert with one another.

To that end it is recommended that the following actions be taken:

1. Each technical committee should establish a task force on LEH appliances comprised of two to four members. These task forces should each include at least one manufacturer and one certification agency engineer familiar with mobile home appliance testing.

2. Energy, Mines and Resources should consider sponsoring a full day briefing session attended by the members of the three task forces and LEH specialist resource people. Information packages should be provided to the members so that each task force uses the same data base for its deliberations.

3. The task forces should meet together again before their recommendations are made to the respective committees to compare the results and resolve any substantive differences in approach and specifications. Interaction among these task forces should be encouraged at all stages.

4. Subject to the results of the standards committee work, consideration could be given to communciating with the manufacturers of appliances that are now certified for use in mobile homes. Issues addressed should be conditions for re-certification, changes to installation manuals and labelling changes, as necessary.

The actions recommended in items 1 - 4 above should adequately address the issues raised in recommendations 5.1 through 5.4 of this report.

5.6 Applicability

The requirements for mobile home appliances that are specified in the existing solid fuel equipment standards are not applicable for appliances intended for use in low energy housing. While the appropriate tests are specified in some of the standards, there are inconsistencies serious enough to warrant concern. The information required in the form of instructions and cautions do not address the issues of importance in low energy housing.

It is therefore recommended that the actions outlined in 5.5 be taken without delay so that suitably labelled appliances are available when the market demand for such equipment becomes greater.

RESIDENTIAL WOOD HEATING

RESEARCH PROJECT ON TECHNICIAN TRAINING, INSPECTIONS AND REGULATION IN ONTARIO

Prepared for the
Renewable and Alternative Energy Group
Ontario Ministry of Energy

Reference No. 616A-8331

Prepared by the
Canadian Wood Energy Institute
March 1984

PREFACE

The burning of wood fuel for residential heating has become a very popular but complicated activity. As recently as ten years ago, woodburning was on the decline and was not considered important as a fuel, nor did it warrant specific attention from regulatory agencies. Since then, however, its use has multiplied several times over, so that today it is the most widely used home heating fuel in the rural areas of Ontario. Wood now provides part or all of the heating needs of nearly one in four of the single dwellings in the province.* Its potential as an optional fuel to expensive imported oil is now recognized by both the Ontario and federal governments.

Since 1978, a number of solid fuel appliance safety standards and an installation code have been developed in response to the need to standardize the safety and installation of the equipment. The standards are new and, while some are now referenced in legislated regulations such as the Building Code, only a relatively few individuals in industry and government have a thorough knowledge of their contents and implications.

The technology itself has become far more complex as the market grew and research yielded sophisticated approaches to this old energy source. Fireplace inserts, specialized chimneys, add-on furnaces, intricate baffling and catalytic combustion are all relatively new developments. A wide array of heat shielding materials has become available, each with different properties and capabilities. The design of a solid fuel installation is no longer simple; literally dozens of important decisions are involved.

It was against this background that a program of professional solid fuel seminars to be held in cities across Ontario was planned for the fall of 1983. Since the seminar sessions provided a unique opportunity to consult people whose day-to-day work involves them in selling, installing or inspecting wood heating systems, it was decided to prepare and administer a detailed questionnaire designed to elicit useful data on current regulatory practice and perceived training needs. The timing of the project also permitted the prompt use of the results by an interministry task force on residential wood heat safety whose first meeting was held in late 1983.

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* Source: Fuelwood Consumption in Ontario, Info Results Limited, 1981.

RESIDENTIAL WOOD HEATING

EXECUTIVE SUMMARY

A program of professional solid fuel seminars, designed to provide current and reliable information to industry members and inspection agencies in Ontario, was presented in the fall of 1983. Part of the agenda of these successful seminars was devoted to the completion of a detailed questionnaire. It consisted of 43 questions on a range of issues but focused primarily on regulatory practice and the training of technicians and inspectors. There were 428 respondents to the questionnaire.

The answers to questions about the present condition of the regulatory system reveal that there are serious inconsistencies in its implementation across the province. It was indicated by the respondents that a large majority of new installations are not presently being inspected and that almost half of the rural areas have no inspection capability available, even though a large proportion of new appliances are installed in these areas. The responsibility for inspections varies from one municipality to another. The only pattern to emerge was that building departments predominate in urban areas whereas fire departments tend to look after inspections in rural areas.

There is little consistency in the guidelines used to judge the acceptability of installations. CSA Standard B365, the installation code that was developed specifically for solid fuels, is rarely used as a guideline mainly because its most current edition has not been referenced in the Fire and Building Codes. Municipal inspectors are unclear on the treatment of uncertified appliances and dual fuel furnaces. Masonry chimneys, which are prone to failure when used to vent solid fuel appliances, are not being inspected during construction with the necessary frequency and thoroughness. Most inspectors have received no special training in solid fuels and most of those that had, felt that it was inadequate. The questionnaire respondents stated almost unanimously that the public is not adequately informed about wood heat safety.

There were clear indications in the responses from installers and retailers that they are capable of and willing to take a larger role in the regulatory system as it relates to wood heat safety. The largest proportion of respondents believed that the installer should be primarily responsible for code compliance. It was, however, acknowledged that a formal program of technician training and certification is needed. Further, they specified a thorough and detailed training course combined with a minimum three month apprenticeship period. A willingness to participate in such a program was almost unanimous. Industry members felt that an installation performed by a certificate holder should not need inspection by a municipal official. They also indicated that they would be prepared to participate in a vendor permit system designed to inform regulatory authorities of new installations.

Inspectors also indicated a desire to receive more training in the field of solid fuels. A training course of at least one week's duration was considered necessary. They felt that support information in the form of a reference text would also be helpful to them in their work.

A number of questions relating to the insurance industry response to rising losses were asked. There was little consistency in the responses although it was apparent that many insurers are applying surcharges to policies where wood is specified as a heating fuel.

In summary, the opinions registered in response to this questionnaire by individuals from both the private and public sectors who are in the best position to evaluate the effectiveness of Ontario's solid fuel regulatory system, indicate that there are valid reasons for concern. They describe a system that lacks central coordination and adequate information at the working level. It was revealed that inspections are not universally available throughout the province. In fact, the majority of installations are not being inspected and the lack of inspection capability is particularly prevalent in rural areas where the concentration of use is the greatest. Furthermore, about half of all installations are made by the homeowner, but the public is not properly informed about wood heat safety.

On the other hand, there is reason for optimism. If given the opportunity, industry members would be willing to participate in the effort to ensure that installations conform to safety codes. Their responses indicate some enthusiasm for a rigorous training and certification program. Overall, the industry revealed itself as concerned and prepared to take on greater responsibilities for regulating the safety of woodburning.

It is apparent that a serious program of training for both installers and inspectors is needed. In addition, it is quite clear that this should be combined with a more accessible and easily understood set of guidelines for judging installation safety. Finally, the public requires more support in its use of wood fuel in the form of information on the nature of the potential hazards and the proper measures to prevent them.

1981 Alberta Building Code

SECTION 9.22 FIREPLACES

SUBSECTION 9.22.1. GENERAL

Fireplaces

9.22.1.1. Except as otherwise stated in this Section, unit masonry shall conform to Section 9.20 and concrete to Section 9.3.

Footings for fireplaces

9.22.1.2. Footings for masonry and concrete fireplaces shall conform to Section 9.15.

9.22.1.3. Except when otherwise specifically stated herein, this Section applies to masonry fireplaces constructed on-site.

9.22.1.4. Combustion air for a fireplace shall be provided by an air intake other than a door or window. *

SUBSECTION 9.22.2. FIREPLACE LINERS

Fireplace liners

9.22.2.1. Except where a fireplace is equipped with an *acceptable* steel liner, every fireplace shall have a firebrick liner not less than 50 mm thick for the sides and back and not less than 25 mm thick for the floor.

High temperature mortar

9.22.2.2. Firebrick liners shall be laid with high temperature cement mortar conforming to CGSB 10-GP-3M(1976), "Mortar, Refractory, Air Setting."

SUBSECTION 9.22.3. WALL THICKNESS

Wall thickness

9.22.3.1. Except as provided in Article 9.22.3.2., the back and sides of a fireplace shall be at least 190 mm thick where a metal liner or a 50 mm thick firebrick liner is used, including the thickness of the masonry liner. Portions of the back exposed to the outside may be 140 mm thick. Joints between a firebrick liner and the adjacent back up masonry shall be offset.

9.22.3.2. When a steel fireplace liner is used with an air circulating chamber surrounding the firebox, the back and sides of the fireplace shall consist of not less than 90 mm thickness of solid masonry units or 190 mm thickness of hollow masonry units.

SUBSECTION 9.22.4. OPENINGS

Support for masonry openings

9.22.4.1. Masonry above openings shall be supported by steel lintels conforming to Article 9.20.5.3., reinforced concrete or a masonry arch.

SUBSECTION 9.22.5. HEARTH

Hearth construction

9.22.5.1. Fireplaces shall have a *noncombustible* hearth extending not less than 400 mm in front of the fireplace opening and not less than 200 mm beyond each side of the fireplace opening.

9.22.5.2. The hearth shall be supported on not less than a 140 mm thick trimmer arch of solid masonry units or not less than a 100 mm thick reinforced concrete trimmer.

SUBSECTION 9.22.6. DAMPER

Metal damper

9.22.6.1. The throat of every fireplace shall be equipped with a metal damper sufficiently large to cover the full area of the throat opening.

SUBSECTION 9.22.7. SMOKE CHAMBER

Smoke chambers

9.22.7.1. The sides of the smoke chamber connecting a fireplace throat with a *flue* shall not be sloped at an angle greater than 45° to the vertical.

Exhaust ventilation system

9.33.2.5. Every *building* in which dust, fumes, gases, vapour or other contaminants tend to create a fire or explosion hazard shall be provided with an exhaust ventilation system designed to conform with Part 6, and shall be provided with explosion relief devices and vents or other protective measures to conform with Part 3.

9.33.2.6. On-site constructed fireplaces or factory-built fireplaces shall be considered fuel-fired *appliances*. *

9.33.2.7. A supply of fresh air shall be provided for *residential occupancies* and, if the *building* is heated by a forced air system, may be introduced at the return air duct upstream from the *furnace* fan. *

9.33.2.8.(1) An outdoor air intake opening 0.008 m^2 or less in area into a return air system shall not be dampered. *

(2) An outdoor air intake opening more than 0.008 m^2 in area but less than 0.033 m^2 in area into a return air system shall be equipped with a manually operated 50% damper. *

(3) An outdoor air intake opening more than 0.033 m^2 in area into a return air system shall be equipped with an automatic damper. *

SUBSECTION 9.33.3. NATURAL VENTILATION

Minimum natural ventilation area

9.33.3.1. The unobstructed ventilation area to the outdoors for rooms and spaces in residential *buildings* ventilated by natural means shall conform to Table 9.33.3.A. Where a vestibule opens directly off a living or dining room within a *dwelling unit* ventilation to the outdoors for such rooms may be through the vestibule.

Table 9.33.3.A.
Forming Part of Article 9.33.3.1.

NATURAL VENTILATION		
Location		Minimum Unobstructed Area
Within *dwelling unit*	Bathrooms or water-closet rooms	0.09 m^2
	Unfinished basement space	0.2 per cent of the floor area
	Dining rooms, living rooms Bedrooms, kitchens, combined rooms Dens, recreation rooms and all other finished rooms	0.28 m^2 per room or combination of rooms
Other than within *dwelling unit*	Bathrooms or water-closet rooms	0.09 m^2 per water-closet
	Sleeping areas	0.14 m^2 per occupant
	Laundry rooms, kitchens, recreation rooms	4 per cent of the floor area
	Corridors, storage rooms and other similar public rooms or spaces	2 per cent of the floor area
	Unfinished basement space not used on a shared basis	0.2 per cent of the floor area
Column 1	2	3

Protection of openings supplying natural ventilation

9.33.3.2. Openings for natural ventilation other than windows shall be constructed to provide protection from the weather and insects. Screening shall be of rust-proof material.

"Standata" Bulletin
Alberta Labour, Building Standards Branch
May 1984

STANDATA

MAY 1984

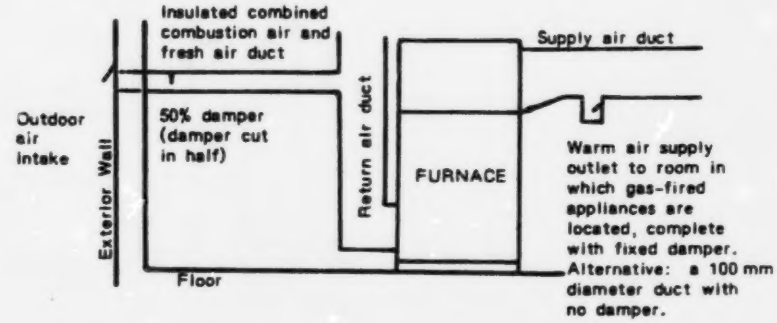
81-T-015 (revised)

COMBUSTION AIR FOR DWELLING UNITS

This bulletin has been developed jointly by the Building Standards Branch and the Plumbing and Gas Safety Services Branch to clarify the requirements for combustion air for gas fired appliances that are installed in dwelling units.

The following two methods are acceptable to both branches and are deemed to satisfy codes and regulations that they administer with regard to installation of gas fired furnaces and hot water heaters in dwelling units. (Other methods that give equivalent performance may be accepted by the two branches.)

METHOD 1


Insulated combined combustion air and fresh air duct
Supply air duct
Outdoor air intake
50% damper (damper cut in half)
Exterior Wall
Return air duct
FURNACE
Warm air supply outlet to room in which gas-fired appliances are located, complete with fixed damper. Alternative: a 100 mm diameter duct with no damper.
Floor

The furnace fan should be run continuously (a two speed fan would be advisable) so that combustion air will always be available for the hot water heater.

The warm air supply outlet supplying the space in which the gas fired appliances are located must be provided with a fixed damper set at the required air volume for the appliances, however a 100 mm diameter duct with no damper is also acceptable.

Normally 10 volumes of combustion air are required for each unit volume of natural gas. In addition to combustion air an equal volume of dilution air is required unless the venting system were to produce the exact draft necessary for each appliance. For the majority of installations 20 volumes of combustion and dilution air need to be supplied to the dwelling unit for each unit volume of natural gas used by the appliances and this air must be brought into the space containing the appliance.

The sizing of the combined combustion air and fresh air duct and the air intake will depend on the quantity of air required for combustion air and for all other air requirements in the building.

ISSUE OF THIS BULLETIN IS AUTHORIZED
BY THE DIRECTOR OF BUILDING
STANDARDS
D. O. MONSEN, M.R.A.I.C.

Alberta

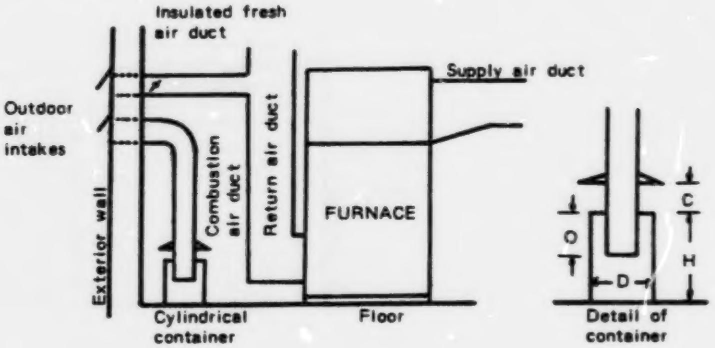
Building Standards Branch
707 - 10808 - 99 Avenue, Edmonton, Alberta, Canada. T5K 0G2

LABOUR
General Safety Services Division

The following table is for guidance only. It assumes that the combined combustion air and fresh air duct is short and has not more than 2 elbows or other restrictions to air flow (not including the 50% damper).

Appliances	Combined Input kW	Minimum size of Combined Combustion Air and Fresh Air Duct
One Furnace & One Hot Water Heater	up to 30	125 mm diameter
	over 30, not more than 45	150 mm diameter
	over 45, not more than 60	175 mm diameter
Two Furnaces & One Hot Water Heater	up to 60	125 mm diameter for **each** furnace
	over 60, not more than 90	150 mm diameter for **each** furnace

METHOD 2



The cylindrical combustion air container must be bottomless so that it can be lifted up to remove debris that may fall in. The container diameter D must be at least 75 mm larger than the diameter of the combustion air duct. The combustion air duct must not extend more than 150 mm into the container (dimension O). The height of the container H must be at least 300 mm. The conical shroud shall be fastened to the combustion air duct, shall have an outer diameter at least 75 mm larger than the container diameter D and the clearance between the bottom of the shroud and the top of the container C shall be not less than 100 mm and not more than 150 mm.

The combustion air duct must be sized to have an area of at least 450 mm^2/kW based on the input rating of all appliances that it will serve.

Warning: The above information about supply of combustion air for gas fired appliances does not take into account other appliances and spaces in the dwelling unit that must be supplied with either make-up or combustion air (examples include attached garages, fireplaces, wood stoves, clothes dryers, kitchen, washroom and other exhaust systems.)

NOTE: 15 kW = 50,000 Btu/h (approx.);
25 mm = 1 inch (approx.)

81-T-015/2
(revised)

APPENDIX C

ORGANIZATIONS CONTACTED

Code Authorities C1

Industry Representatives C3

(Provincial code authorities contacted
are listed in Appendix D: Interview Documentation)

Code Authorities

American Gas Association
Cleveland, Ohio
Forrest Hammaker, Secretary 216-524-4990
ANSI Z223 Committee

Canada Mortgage and Housing Corporation
Ottawa
Peter Russell 613-748-2306
Technical Research Division

Canadian Gas Association
Don Mills
Patricia Wenning 416-447-6465
Standards Administrator, B149 Committee Secretary

Canadian General Standards Board
Ottawa
Robert Charest, Secretary 613-997-5710
Air Sealing Committee

Canadian Standards Association
Toronto
Lyn Bortolin, Secretary 416-747-4106
Solid-Fuel and Oil Committees

Brian Rossborough 416-747-4365
Senior Standards Administrator

Dr. Bill Lowe 416-747-4111
Manager, Renewable Energy Programs

Ted Tyne 416-747-4240
Standards Administrator

Energy, Mines and Resources Canada
Conservation Branch
Ottawa
Mark Riley, Head 613-995-1118
R2000 Program

Energy, Mines and Resources Canada
Combustion Research Laboratories
Ottawa
Skip Hayden, Ron Braaten 613-996-4570

Energy, Mines and Resources
Ontario Conservation and Renewable Energy Office
Toronto
Tex Macleod 800-268-1197
Ontario Government Task Force

National Research Council of Canada
Division of Building Research
Ottawa
R.J. Desserud, Technical Advisor 613-993-9960
Codes and Standards Group

Asbjorn Hansen 613-993-2607
Technical Information Group

Frank Steel 613-993-1231
Building Performance

Prairie Regional Station, Saskatoon
Rob Dumont 306-665-4200

Ontario Ministry of Energy
Energy Conservation Group
Toronto
Allan Turton, Advisor 416-965-9877
Municipal Conservation Group

Ottawa Building Branch
Ottawa
Des McKenna 613-563-3100
Chief Mechanical Engineer

Standards Council of Canada
Ottawa
Ellen Bujold, Informations Officer 613-238-3222
Standards Information Division

Industry Representatives

Allen-Drerup-White Ltd.
Toronto
Greg Allen 416-863-1762

Canadian Wood Energy Institute
Toronto
John Guenin, Executive Director 416-445-6296

Clare Brothers Manufacturers
Cambridge
Ted Clare 519-653-6247

Consumers Gas
Scarborough
Glen Palmer, Manager 416-492-5000
Service Administration

Heating, Refrigeration and Air Conditioning Institute
Toronto
Doug Geddes, Manager 416-239-8191
Educational Services

Hubert Heating Ltd.
Ottawa
Robert Hubert 613-728-3786

Low Energy Building Group
Ottawa
Bruce Gough, President 613-232-5393

Mechanical Contractors Association of Canada
Ottawa
Hal Gillis, Exec. Vice President 613-232-0492

Ottawa Gas
Ottawa
James Larkin, Service Manager 613-741-5800

Performance Woodburning Inc.
Killaloe, Ontario
John Gulland, Consultant and representative on B365 Committees 613-757-3144

Retrotech Energy Innovations Ltd.
Ottawa
Brendan Reid 613-745-1515

Scanada Consultants Ltd.
Ottawa
Mike Swinton 613-236-7179

Solterra Developments Ltd.
Ottawa
Lynn Schmidt, Secretary/Treasurer 613-729-3116

APPENDIX D

INTERVIEW DOCUMENTATION

Provincial and Local Officials

Organization	Newfoundland Dept. of Municipal Affairs Provincial Planning Office St. John's
Phone No.	709-576-3090
Contact Person	J.T. Allston
Title	Director of Urban and Rural Planning
Date	84-12-6

Code in Use	Nfld. has not adopted the NBC, but requires municipalities to adopt their own but accepts only 1980 NBC. 1985 NBC expected to be adopted. 244 of 306 municipalities now use 1980 NBC. The construction, alteration or reconstruction of buildings, except for one and two family dwellings, must comply with the standards of both the National Building Code and the National Fire Code, and must be referred to and approved by the Fire Commissioner before a council may issue a building permit. Therefore, the only applications for a building permit that a council can approve without referral to the Fire Commissioner are those for one and two family dwellings.

Organization	Nova Scotia Dept. of Municipal Affairs Community Planning Division Halifax
Phone No.	902-424-8046
Contact Person	Ms. Helena Whyte
Title	Coordinator, Municipal Training Services Member, Provincial Code Advisory Board
Date	84-12-6

Code in Use	No provincial code. A bill to adopt NBC was passed in the mid-1970's but never given approval. The issue flares up occasionally. 49 of 66 municipalities have voluntarily adopted the 1980 NBC, the only one acceptable to the province. 1985 NBC is expected to be adopted. The original bill improved on the 1977 Energy Conservation Measures but the Design Council, particularly the architects, fought against it, but the government supported it.
Code Requirements	The Fire Marshall examines all building plans except single or duplex residences for conformance to fire safety regulations.
Application of Code	Probably many retrofit installations without permits and "all kinds" of fatalities from faulty wood-fired installations.

Organization	P.E.I. Dept. of Municipal Affairs Charlottetown
Phone No.	902-892-0311
Contact Person	Jerry MacDonald
Title	Chief Property Development Officer
Date	84-12-6

Code in Use	1980 NBC in Charlottetown and Summerside; rest of island has no code. The National Plumbing and Electrical Codes are in effect, and P.E.I has its own Fire Prevention Act.
Permits/Inspections	Only a Development Permit is required, which checks that zoning requirements are met. No construction permits are required.
Internal Interpretation	The most common problem is reported to be excess humidity. Solved by using roof-top ventilators [probably through-ducted to the basement].

Organization	Department of Supply and Services Province of New Brunswick P.O. Box 6000 Fredericton, New Brunswick E3B 5H1
Phone No.	(506) 453-2140
Contact Person	Robert Lynch
Title	Executive Director of Buildings
Interview Date	85-3-19

Code in Use

All municipalities in N.B. are supposed to adopt the 1980 NBC. About 95 of approximately 120 have done so and most of the small municipalities that haven't use the NBC anyway. In rural areas on the Health Dept. and Electricity Code requirements are followed.

It is intended that once the 1985 NBC is available it will the required version.

Enforcement of retrofit installations is "hard to control." The local bldg. inspector is "supposed to" issue permits and perform inspections.

Lynch says that combustion air is a problem, but the incidents cited relate to fires rather than asphyxiation and appear to be chimney/venting problems not related to air supply.

There is little gas in the province, and what propane is used is mostly for transportation.

Mobile homes in N.B. are usually outside municipalities in trailer parks, under the jurisdiction of Dept. of Municipal Affairs and not the bldg. inspector.

Organization	Ministère de l'Habitation et de la Protection du Consommateur Direction générale de l'inspection 425 rue St-Amable Québec, Québec G1R 4Z1
Phone No.	(418) 643-9471
Contact Person	Jean Couture
Title	Engineer
Interview Date	85-3-21

Code in Use

The 1984 Quebec Building Code is based on the 1980 NBC but it only applies to public and large buildings. Small buildings, those covered under Section 9 of the NBC, are excluded.

Municipalities must adopt the NBC or their own building code. Many of the small municipalities have none at all, but of those that do have a code, probably 80% use the NBC, with the remaining 20% using their own.

In some municipalities, the building inspector may have other responsibilities and the provincial ministry does not have a feel for the extent of inspection or compliance.

Organization	Quebec Association of Municipal Inspectors
Contact Person	Yvon Campbell
Title	Municipality of Granby
Phone	514-372-6671
Date	

INTERVIEW DOCUMENTATION

Organization	Ontario Ministry of Consumer and Commercial Relations Fuels Safety Branch Toronto
Phone No.	416-585-6666
Contact Person	Don Beck
Title	Standards Engineer
Interview Date	85-3-19

Code in Use	Ontario Gas Utilization Code is based on B149, although 6.4.4 states that automatic dampers are not permitted on single or double family occupancies.
Application of Code	Automatic dampers are allowed in commercial installations with an interlock, which is the same requirement as B149 for residential. Will probably be revoked, a good thing as an automatic damper is better than an open pipe which consumers probably block up anyway.
Technical Basis	He knows of no technical studies to determine actual combustion air supply requirements, but thinks they were based on certain assumptions of so many cubic feet per second through the duct. However, that may simply have been a rationalization of pre-existing rules of thumb.
New and/or Retrofits	Beck indicates there is a trend to eliminate natural aspirating equipment and require induced draft fans. Passive ducts, he says, are too dependant on wind forces. He indicated that manufacturers will probably come up with a retrofit inducing fan for existing equipment.
Activity on Modification	He thinks there will be a number of changes accepted by the B149 committee in mid-May 1985.
Implementation	Inspections are done by the utility when new piping is installed. The Fuels Safety Branch has 35 field inspectors.

Organization	Ontario Ministry of Municipal Affairs and Housing
Address	Buildings Branch
Phone No.	416-585-6666
Contact Person	Richard Massabki
Title	Advisor
Date	85-1-15

Code in Use	Ontario Building Code 1983, based on 1980 National Building Code.
Code Requirements	Solid fuels only, references the older 1982 version of B365.
Permits/Inspections	All municipalities require permits and inspections for new construction.
Internal Interpretation	Manufacturer's instructions are considered to over-ride B365.

Organization	Energy, Mines and Resources
Address	Ontario Conservation and Renewable Energy Office
Phone No.	1-800-268-1197
Contact Person	Tex Macleod
Title	Member, Ontario Government Task Force
Date	85-1-15

Application of Code	Ontario Building Code (OBC) covers new construction and "material alteration" only; whether this covers wood stoves varies with jurisdiction. Fire code comes into place if OBC only covers new construction. Renovation section of OBC doesn't cover heating, but references Section 9. 1971 Energy Act, which empowers the Fuel Safety Branch, removed solid fuel from definition. Combination units are covered half by Fuel Safety and half by the Building Code. Insurance inspectors, usually untrained and unqualified, may inspect in jurisdictions without permit/inspection requirements.
Permits/Inspections	London doesn't require a permit for a wood stove to connect to an existing chimney, but does for a new chimney. Ottawa requires a permit for all solid-fuel installation.
Mobile Homes	Gray area of responsibility; Ont. Bldg. Code references CSA Z240 codes.

Organization	City of Ottawa Buildings Branch
Phone No.	613-563-3100
Contact Person	Des McKenna
Title	Chief Mechanical Engineer
Interview Date	85-1-15

Code Requirements

Until a few years ago, natural infiltration was sufficient and no problems were experienced. Now, with increased attention to fuel consumption and heat losses, provision has to be made for combustion air. In most new construction, gas-fired installations have combustion air supply in the basement, or in a furnace room if there is one.

There have been no complaints of insufficient air supply except for fireplaces and, to a lesser extent, wood stoves. 60-70% of new single-family dwellings have factory-built fireplaces; with a factory-approved air supply system these are fine. Stoves are found only in retrofits; 70-80% get a permit. There have been a few complaints of gas furnaces backdrafting in existing homes, particularly with fireplaces.

With new construction, owners frequently block the combustion air supply ducts.

The municipal building permit covers the building plus the heating system; the furnace installation is the responsibility of the Fuels Safety Branch in Toronto who leave it up to the local utility; however, the city inspector checks the furnace anyway.

For retrofits, a separate HVAC replacement permit is required, although the city does not have sufficient staff to inspect all gas conversions (approx. 2000 per year) and relies on the gas utility who do an inspection before the gas line is turned on. Generally gas retrofits do not provide combustion air ducts.

"Rarely" do oil installation include combustion air ducts, even in new construction.

Organization	Ontario Building Officials Association
Contact Person	Secretary/Treasurer Mr. Peter Finn Chief Building Official Emily Township Municipal Office R.R. 4, Omemee, Ontario KOL 2WO
Phone No.	705-799-6010
Interview Date	

Organization	Ontario Ministry of Consumer and Commercial Relations Fuels Safety Branch
Address	Toronto
Phone No.	416-239-2948
Contact Person	Bill Drake
Title	Technical Supervisor
Date	85-1-15

Code in Use	B149 for gas, B139 for fuel oil
Code Requirements	Under Ontario Energy Act, in place since early 1970's, this Branch has responsibility for gas and oil installations; solid fuels come under the Ontario Building Code.
Application of Code	For gas installations, inspections done by utility on behalf of Branch. Oil installations are responsiblity of installer or owner, with inspection by municipality if there is a bylaw requiring permits and inspections. Most municipalities don't have such a bylaw, only the major ones.
Permits/Inspections	For solid fuels, only enforced at municipal level. Jurisdictional problem: are solid fuel retrofits covered under OBC? An Ontario government task force will report by late January 1985, recommending either that the Building Code cover all solid fuel installations or that the Fuel Safety Branch assume responsibilty for solid fuel installations as well as gas and oil.
Retrofits	Under the Ontario Building Code, the municipalities have to decide if they have jurisdiction as the Buildings Branch of the Ministry of Municipal Affairs (the provincial agency responsible for the Building Code) has not given its interpretation of "material alteration." If the retrofit installation of any combustion device is considered a major renovation then the code applies; if it is not a major renovation then the code does not apply.
Implementation in Field	Suspects that 50% of solid fuel installations done by owners without permits, about 10-15% by owners with permits, and the rest by professional installers with or without permits, depending on local bylaws.

Organization	Dept. of Labour and Employment Services
Address	Office of the Fire Commissioner Room 611-401 York Ave. Winnipeg, Manitoba R3C 0P8
Phone No.	204-945-3322
Contact Person	Earl Berlin
Title	Technical Engineering Officer
Date Contacted	85-1-15

Code in Use	The Manitoba Building Code is based on the 1980 National Building Code; 1985 Code is expected to be adopted the year following its release. The Fire Commissioner is responsible for solid fuel installations only. Oil and gas installations are the responsibility of the Mechanical Engineering Division of the Department of Labour, where the Supervisor of Inspectors is Paul Hagen, 204-945-3378.
Code Requirements	Solid fuel requirements are "almost word for word" the same as 1980 NBC

Organization	Dept. of Labour and Employment Services
Address	Office of the Fire Commissioner Winnipeg, Manitoba
Phone No.	204-945-3322
Contact Person	George Petrycky
Title	Technical Services Officer
Date Contacted	85-3-21

Code in Use	The requirements for solid fuel equipment are currently being amended. The amendment, when enacted, will mandate B365-1984.
Internal Interpretation	Although it is not clear how soon B365-1984 will be legally enforceable, inspectors are already considering B365-1984 as the current requirements.

Organization	Manitoba Dept. of Labour Mechanical Engineering Division
Phone No.	204-945-3378
Contact Person	Paul Hagen
Title	Supervisor of Inspectors
Interview Date	85-3-19

Code in Use	Manitoba Bldg. Code, based on 1980 NBC
Code Requirements	B139 for oil installations, B149.1 for natural gas and B149.2 for propane
Internal Interpretation	Gas Notices are published, not amendments but explanations and interpretations. Variations are allowed in commercial installations, but not in residential which are required to follow the code.
Mobile Homes	Bldgs and Mobile Homes Act considers mobile homes as houses; they are required to follow CSA's Z240 series of standards.
Activity on Modification	Thinks 1985 NBC will not be adopted, will continue to use existing Manitoba Building Code.

Organization	Dept. of Labour Occupational Health and Safety Div. Technical Safety Services Branch
Address	Regina, Saskatchewan
Phone No.	306-565-4509
Contact Person	Bert Sheasby
Title	Director
Interview Date	85-1-16

Code in Use	Since 1984, 1980 NBC for most of population. Outlying areas have no code; some municipalities use older version of NBC. In early 1986 the 1985 NBC will be adopted as the Sask. Bldg. Code.
Code Requirements	Tech. Safety Services Div. also responsible for gas installations. Since B365 is not specified in 1980 code, no control over solid fuel installations.
Application of Code	Major cities require permits, but varies with municipalities. Permits and inspections are not required in small villages and towns. Permits are required for change-over to gas, but no separate air supply is required unless the furnace is installed in an equipment room.
Internal Interpretation	Combustion air supply is not required in single family units as natural infiltration is considered sufficient, even in tight energy-efficient housing. Combustion air supply only required for installations with the furnace in a separate room. One problem is considered to be fireplaces backdrafting gas furnaces, but no fresh air is required for fireplaces, and although "quite a few" fireplaces are installed without permit or inspection, no fatalities have been reported from the backdraft problem.
Implementation	Some reported cases of owners blocking ducts to prevent cooling of basements, although problem more common in commercial/industrial with laundromats plugging ducts resulting in insufficient air for combustion.

Organization	Alberta Labour General Safety Services Division Building Standards Branch
Phone No.	403-427-8265
Contact Person	R.N. (Dick) Massiah
Title	Associate Director, Field Services
Interview Date	85-1-16

Code in Use	1981 Alberta Bldg Code, based on 1980 NBC. 1985 NBC expected to be adopted in mid-1985. Alta. is almost exclusively gas heated, so combustion air supply in single family residences comes under the Gas Protection Branch. The province's few oil-fired installations by default come under the jurisdiction of the Fire Protection Branch, but this will cease with adoption of the 1985 Code. Wood-fired add-ons are not allowed.
Code Requirements	For fireplaces, combustion air "shall be provided by an air intake other than a door or window." This requirement does not apply to wood stoves, which have only become popular within the last few years. May be only province with fresh air requirements.
Internal Interpretation	Inspectors look for a source for fireplace combustion air within the room. Since the gas furnace installation requires an outdoor air supply, a duct connecting the room with the fireplace to the basement is recommended. Direct ducts from the fireplace to the outdoors are also accepted. The province also has a fresh air requirement in residential occupany that may be met with an outdoor duct connecting to the return air duct of the furnace. This does not meet the combustion air requirement.
Permits/Inspections	No provincial requirement for permits, although 95% of the population is covered by municipalities which do require permits for solid-fuel installations.
Implementation in Field	The problem of combustion air supply in tight houses is minor, thanks to a public education program with seminars and pamphlets on the requirements for fresh air. For the last 9 years, only 2 cases have been reported of people being hospitalized due to back-drafting.
Documentation	Requirements on fresh air and combustion are included in Appendix B.

Organization	Alberta Labour General Safety Services Division Building Standards Branch
Phone No.	403-427-8265
Contact Person	Ian Peacock
Title	Mechanical Services
Interview Date	85-3-21

Solid-Fuel Equipment

The 1981 Alberta Bldg. Code contains no specific requirements for solid-fuel equipment combustion air. The former 1978 Alberta Code contained a specific opening size per so many Btuh input, but the requirement was dropped with the current code as it was deemed impossible to determine the heat input for solid-fuel equipment, since the capacity would vary with the type of wood or coal used.

Internal Interpretation

The current code simply specifies that the combustion air suppy be "adequate." This is interpreted as calling for a duct "equal to or bigger than the flue collar." So-called airtight wood stoves are referred to as "slow-burning appliances." Inspectors permit these to be installed without an exterior air supply as the duct to the gas furnace is considered adequate. All other types of stoves, however, are required to meet the same requirements as fireplaces, preferably a direct duct to the outdoors as close to the appliance as possible.

Organization	Ministry of Municipal Affairs Building Standards Branch Victoria, B.C.
Phone No.	604-387-5925
Contact Person	Watson Smith
Title	Building Standards Officer
Interview Date	85-1-16

Code in Use	1980 NBC adopted by province and revisions up to Jan 84. 1985 NBC will be adopted.
Code Requirements	Solid fuel requirements are only enforced in mobile homes, not in normal houses where there is no requirement for outside air supply. 1985 Code will be enforced, including fireplaces. For the last 2-3 years solid fuel requirements have been more vigorously enforced and the standard of inspections "has gone up 100%" although there still are installations without permits.
Application of Code	Different requirements for loose vs. tight houses considered "a dangerous approach" as trend continues to tighten up existing houses. When 1985 code is adopted, the province is expected to make a blanket requirement for a minimum size air intake for stoves and fireplaces, with a variable manual damper so that owners can close duct when not in use.
Permits/Inspections	Permits required for "anything that affects safety or health." Province has ruled that that covers fireplaces and stoves; therefore all solid-fuel installations, new and retrofit, require permits and inspections. Insurance companies require a permit for solid-fuel installations.
Internal Interpretation	Don't know how to meet requirements in 85 NBC to supply replacement air.
Implementation in Field	Ministry of Municipal Affairs enforces Building Code, including oil equipment. There is no natural gas on Vancouver Island. Gas installations handled by Ministry of Labour in Vancouver.

Organization	Ministry of Labour Gas Inspection Branch Vancouver, B.C.
Phone No.	604-879-7531
Contact Person	Jim Smith
Title	Codes and Standards Engineer
Interview Date	85-1-16

Code in Use	B149.1 for natural gas since 1954. B149.2 for propane since 1982.
Code Requirements	B149 followed closely.
Application of Code	Outdoor air supply is required in all buildings, with no distinction for loose bldgs with natural infiltration.
Permits/Inspections	Permits are required for all installations. Try for 100% inspections, even in north, and come "pretty close." Some propane installations on Vancouver Island but no natural gas.

Organization	Government of the Yukon Territory Protective Services Branch Whitehorse, Yukon
Phone No.	403-667-5217
Contact Person	Bud Pollock
Title	Chief Building Inspector
Interview Date	85-1-16

Code in Use	1980 NBC, with automatic adoption of revised codes.
Application of Code	Virtually entire territory is covered, including Indian bands as Indian land is not classed as reserves, so Building Inspector has jurisdiction and requires permits and inspections. Thanks to a strong public awareness problem, people come for advice before installation (and even before buying) and request a safety inspection. Insurance companies require a report from the Building Inspector for all combustion retrofits. Installers are aware of code requirements and ask advice from Bldg. Inspector for problem installations. EMR's CREO refers people to the Bldg. Inspector for specific advice. Bldg. Inspector is "reasonably pleased" with situation.
Permits/Inspections	Required for all retrofit combustion equipment. New construction requires a building permit. For new construction and major retrofits, the Bldg. Inspector recommends and requires combustion air supply, but for older houses will accept infiltration with proof that sufficient air is being supplied.
Internal Interpretation	Outdoor air supply is recommended in all instances even if natural infiltration is high enough, in case owner later seals house. This is official policy. Trades used to install 6" ducts, but dropped size. Inspector allows 4" ducts but not 3".
Implementation in Field	Trade practice is to install outdoor air supply. If plumbing is in the same space, ducts come in at ceiling level and drop to 6-8" from floor. This exposed duct allows for preheating of air. Owners may plug ducts in open basements and allow for infiltration to supply combustion air. Usually basements are finished and then the ducts are needed. Some complaints of combustion fumes in furnace rooms with washers and dryers.

Organization	Government of the Yukon Territory Protective Services Branch Whitehorse, Yukon
Phone No.	403-667-5217
Contact Person	Larry Hipperson
Title	Fire Marshall
Interview Date	85-3-21

Code in Use

At least five years ago the fire marshall was able to have an order-in-council passed requiring combustion equipment to have a combustion air supply duct one-half the diameter of the chimney size.

Another order-in-council has been submitted to cabinet to mandate B365-1984, but it is expected to die as the 1985 NBC will be adopted automatically as soon as it is released.

Technical Basis

The fire marshall determined the half-the-chimney figure after discussions with his own people, local installers and Ted Tyne at CSA. A ratio of 0.5 seemed to be the generally accepted figure.

Internal Interpretation

It has been the internal requirement of the fire marshall's office and the practice of local installers to install forced air furnaces with a combustion air duct one-half the size of the flue and connect it to the return air duct. Similarly, stove and fireplaces are required to have a combustion air duct. On stoves the duct may have a damper, but the duct needs to discharge in the vicinity of the combustion chamber.

These requirements appear to have come into effect as the result of problems in the past, particularly with fires but also, to a lesser extent, with near-asphyxiation.

Inspections

The building inspector works under the fire marshall. Heating inspectors are also used.

Organization	Government of the Northwest Territories Justice and Public Services Fire Safety Division Yellowknife, NWT
Phone No.	403-873-7469
Contact Person	Mr. McFee
Title	Fire Marshall
Interview Date	85-1-15
Code in Use	1980 National Building Code. CSA B365-1984 for solid fuels is already in use, plus CSA B139-76/81 for oil and CGA B149-80 for gas and propane. The 1985 NBC will be switched to as soon as possible, an automatic procedure applying to all NBC revisions plus CSA, CGA and ULC standards, simply requiring notification in the newspaper.
Application of Code	In place territorially and in the municipalities. Gas is a new fuel source and only available in 2-3 communities.
Permits/Inspections	All installations are inspected by the Fire Marshall, but no permits are required. Insurance companies require a letter from the Fire Marshall for all solid fuel installations.
Implementation in Field	"Lucky to get 60% of all installations", but the codes are followed closely. In one case, a small chapel, a propane-fired installation had insufficient combustion air and backdrafted. This installation did not look tight and was not inspected, therefore there are probably similar installations elsewhere. The solution was to undercut the door to the adjacent space, an unheated porch. This use of drawing combustion air from an unheated space such as a crawl space or porch is regarded as a good solution, as ducting air directly from the outdoors means that in cold weather the furnace never turns off. The only R2000 houses are in Yellowknife and probably not many in NWT. These will have to have their combustion air ducted from the outside, but how will this air be preheated?